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ABSTRACT

The project on Girls and Science and Technology (GASAT) consists of bringing together individuals involved in research and development projects to examine ways to increase the participation of girls and women in science and technology education, by organizing international conferences. This seven-part document provides: (1) a discussion of the GASAT problem leading to the first international GASAT conference (considering causes of the GASAT problem and other topics); (2) the opening conference address by Bernardijn ten Zeldam (deputy secretary-general of the Dutch Ministry of Education); (3) a discussion of schooling in the Netherlands, England and Wales, Sweden, Norway, Federal Republic of Germany, Portugal, Canada, and the United States; (4) descriptions of initiatives taken in these countries to resolve the GASAT problem; (5) summaries of working group suggestions/recommendations related to teacher education, support activities for women and girls, and curriculum and teaching materials; (6) a consideration of future directions; and (7) a 14-page bibliography of publications cited by GASAT participants in their contributions to the conference and judged to be of relevance to the subject. (JN)

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GIRLS AND SCIENCE AND TECHNOLOGY

Congressbook GASAT - conference 1981

Backgrounds and Emphases

GASAT - 1981
volume 3

Eindhoven University of Technology
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PREFACE

The first international GASAT - conference
GASAT = Girls And Science And Technology
was held at the Eindhoven University of Technology (THE)
in Eindhoven, The Netherlands, November 9 - 13, 1981.

A short report of the conference is published in *PROCEEDINGS GASAT CONFERENCE 1981*, vol. 1.

Volume 2 *CONTRIBUTIONS* contains the full text of the papers brought in by the participants to serve as a basis for the discussions. Most of the papers are reproduced in the way they are received. The reader may excuse some minor language or typing mistakes.

The editors felt it important to publish the available material and thus to make it more accessible to the growing number of persons concerned about promoting education in science and technology for young girls and women in various countries.

This volume 3 *GIRLS AND SCIENCE AND TECHNOLOGY, GASAT - conference 1981* presents backgrounds of the problem, information about the structure of different educational systems and the place of science, and an outline for the future.

The editors

Eindhoven University of Technology,
September, 1982.

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1. Introduction. The GASAT problem leads to GASAT Conference-1

Many people now recognise that girls and young women have a disadvantage in education, especially in the physical sciences (physics and chemistry) and in technology (engineering and applied science). But until recently this was not seen as a problem and aroused little public discussion.

What is the GASAT problem?

GASAT = Girls and Science and Technology.

The extent of the difference in involvement of boys and girls, men and women in science and technology studies can be shown by statistics. For example in England (where most young people now attend comprehensive secondary schools) only 12% of all girls but 50% of boys study physics after the age of 14 years, and fewer do so after 16 years. In the Netherlands, where secondary education is still, at present, selected by ability, with 60% of pupils proceeding to some type of general secondary school (vwo = preparation for university; havo = preparation for higher vocational school; mavo = preparation for middle vocational school) the figures are as shown in Table 1.

	girls	*boys*
vwo	26	61
havo	11	45
mavo	11	50

Table 1. Percentages of girls and boys choosing physics for final examination, in the Netherlands, 1979/80.

When the Science Council of Canada initiated a review of science education the investigators found that in many Provinces it was not known how many girls were studying science in school, so data are now being collected. At university level the figures show also that few women are involved in physical sciences and technology. In the USA women formed the following percentages of those receiving first degrees in 1980: 37% in behavioural sciences, 38% in life sciences, 18% in physical sciences and 7% in engineering. Women contributed only 5% to undergraduates in engineering in the UK in the same year (although this was an improvement of

100% over the figure for 3 years earlier!), while in the Netherlands women formed 4% of physics students in general universities and those in universities of technology only 2%.

Why should we be concerned about the GASAT problem?

Science and technology are exerting more and greater influence on the lives of men and women in modern society. If women are not involved from an early age in these activities they develop a sense of alienation from them. This is neither good for women's mental health nor good for society, where many decisions have to be made in connection with the uses of science and technology. In a democratic society women form half of the adult population involved in making these decisions and if they feel alienated they are not able to make informed and objective judgements. But, in addition, many skilled and interesting occupations depend on scientific and technical qualifications. If we support the principle of equal opportunities for boys and girls, women and men, we must ensure that girls are not *prevented* from participating in these through early decisions to drop important qualifying subjects such as physics or mathematics.

So we are concerned about the GASAT problem and wish to bring about changes so that more girls and women study and work within science and technology. To do this we must understand how the differences between males and females in this area come about.

What are the causes of the GASAT problem?

Several factors have been suggested as being responsible for the lower participation of girls and women in science and technology. They will be briefly summarized, and commented on here, but more detailed consideration may be found in Chapter 4 of this book and in Vol. 2 of the GASAT Conference 1981 (which contains the papers submitted by the conference participants).

The question of *different abilities* is sometimes raised, but a review of sex differences research (Maccoby and Jacklin, 1974) concluded that the only substantiated differences were

in verbal abilities, where females have an advantage and in spatial abilities, where they suffer a disadvantage. However, these mean differences are small and negligible compared with the great range of abilities shown within a group of males or within a group of females. The remarkable thing is not the *difference* between male and female abilities, but how *similar* they are. So that differences in ability cannot be used to account for the GASAT problem. It will appear that the contributors to the GASAT Conference assume that the cause of the problem is *sociological*, that the girls make different choices from those of the boys because they receive many messages that they *should* be different.

In society as a whole the roles of men and women have been different and separate; men do a job outside the home, often involving technology, and women stay at home, caring for children. Although this may be changing, messages about their appropriate roles are strongly transmitted to girls and boys. This is done through the toys they are given (boys get cars, trains and constructional toys and never a doll, unless it is 'Action Man', while girls get dolls, miniature kitchen equipment etc.), through the books they read (where mother stays at home and father goes to work, Janet helps mother in the kitchen and John helps father with the car, or painting the house) and through the magazines they read or the television programmes they watch.

They quickly absorb and internalize these roles, boys seeing themselves as masculine and girls as feminine. Some of the characteristics which surveys have shown as ascribed to males and females are shown in Table 2.

male	*female*
active	passive
competitive	cooperative
commanding	submissive
adventurous	cautious
aggressive	peaceful
technical	verbal
rational	emotional
logical	sensitive

Table 2. Some so-called male and female characteristics.

The practice of science and technology is seen to require many more 'male' characteristics than female and so boys choose physical science and technology far more often than girls do.

The messages are also reinforced in schools. Observations have shown that teachers treat girls differently from boys. They assume that girls have 'feminine' characteristics, and that it is quite in order for these differences to exist. So they make fewer achievement demands on girls than on boys, especially in science, technology and mathematics.

Science is actually presented as a male activity in the textbooks that pupils use. Several studies of this phenomenon have been carried out (in England, Norway and the Netherlands, for example) and efforts are being made to change this by including examples of women working in technical activities and using language which shows clearly that girls as well as boys are expected to be participating in the study of this subject.

It seems that many girls are not aware of the changing patterns of women's employment. In the USA and the UK women formed 40% of the work force in 1980; the number of married women who work is increasing (67% in the UK in 1980) for a variety of reasons.

Nor are girls aware of how essential it is to have studied physics or chemistry to enter some occupations and so they are disappointed to find they do not possess the required qualifications to enter such fields as medicine, agriculture, pharmacy and so on. The education system is failing in not encouraging girls to look at realistic life patterns for women.

The factors mentioned above are only some of those which strongly discourage girls and women from participating in science and technology. The GASAT Conference brought together some of the people who are working to change this.

How the idea of the GASAT Conference arose

It is rather difficult to give a short description of the way the idea of the first GASAT Conference (GASAT = Girls And Science And Technology) came about, to know where to start, what to mention and what to leave out. However, we will try to give some idea of how it all began.

In the Netherlands, in December 1979, at the annual conference of physics teachers, it was suggested that 'girls and physics' should be the topic of the next conference. The participants in 1979 at first thought the suggestion was just a joke, not even worth considering. But, as the meeting progressed, the idea was taken more seriously and finally a number of the teachers accepted that it was an issue and should, at least, be discussed. The Woudschoten-conference, 1980, did not concentrate on one subject, as usual, but included several. One of them was the problem of girls and their disadvantage in the teaching and learning of physics.

The spring of 1980 saw the start of the HANDROVER-project. This set out to study sex-stereotyping in textbooks and to write guidelines for better books. Ilja Mottier, responsible for the project, decided to begin with three special subjects: modern languages, history and physics. It was planned to demonstrate the extent of stereotyping by sex in each of these fields and to develop guidelines with two components: general recommendations relevant to any textbook and those specific to individual subjects (modern languages, physics and history, in the first instance).

Towards the end of 1980 Ilja Mottier and Jan Raat collaborated to write a report describing the situation of girls' education in physics. This was entitled 'Marie, word wijzer ... van natuurkunde' (in English: Mary, get wise ... by physics) and was used at the conference of physics teachers in December 1980. Subsequently, a project, 'MEisjes, Natuurkunde en Techniek' (MENT) (in English: Girls, Physics and Technology) was set up under the direction of Jan Raat at Eindhoven University of Technology.

In England, the problem had been identified a little earlier. Jan Harding organized a conference, 'Girls and Science Education - Cause for Concern?' in March 1975 at Chelsea College, London. She then coordinated two symposia (1977 and 1981) on the subject at Annual Meetings of the Association for Science Education (ASE) and chaired the sub-committee, 'Girls and Physical Science' (GaPS), of the Association. A major project, 'Girls into Science and Technology' (GIST) had been funded in Manchester with Alison

Kelly and Judith Whyte by the Equal Opportunities Commission (EOC) and the Social Science Research Council (SSRC). The Engineering Industry Training Board (EITB) supported an initiative of Geoff Chivers at Loughborough University on girls into Engineering (this later extended to 9 other universities) and British Petroleum (BP) had funded a fellowship at Chelsea College in 'Girls and Technology Education' (GATE). Several visitors from overseas, passing through London, called at Chelsea College to discuss the problems surrounding girls and science and technology. Among these were Jan Raat (Holland), Svein Lie (Norway) and others from France, Canada, the USA and Australia.

Then, early in 1981, Mottier, Raat and Harding met for the second time. We three discussed the work we were developing and shared information from our meetings with others. It seemed that everywhere the problem was becoming visible and many initiatives were being taken to try to solve it. The idea arose to have an international conference so that all those women and men working in projects about girls and science and technology (= GASAT) could meet together, share at first hand their experiences and learn from each other. We agreed to think it over and look for possible ways of bringing such a conference about.

A few weeks later negotiations in Holland had resulted in the promise of a grant from the Dutch Department of Education to finance a small conference of 30 people (including 20 from countries outside the Netherlands) and the locating of the host institution: the Technische Hogeschool Eindhoven (THE), where Jan Raat is professor of Physics Education.

Mottier, Raat and Harding formed a programme-invitation committee, while personnel from the THE Physics Education Department formed a preparatory committee to meet all the organisational requirements for a conference in the autumn of 1981.

As time was short, direct invitations were sent to those people, working in the field, who were known to the programme committee. In the USA recipients of 1981/2 National Science

Foundation awards for projects aiming to support women into science were contacted. Eventually papers from twenty-one participants were received and circulated well before the opening of the conference. These papers may be found in full in *GASAT Conference, 1981. Contributions (Vol.2)*, while a brief report of the proceedings of the conference is contained in *GASAT Conference, 1981. Proceedings (Vol.1)*.

In this text we try to give more of an overview of the GASAT problem and how we might solve it, but draw on the experience of the GASAT Conference to do so.

The opening address of the Conference was given by Ms.ir. Bernardijn ten Zeldam, the Deputy secretary-general of the Dutch Ministry of Education. This forms chapter 2 and in it the reasons for our concern are clearly expressed.

It will be apparent that in the various countries represented at the conference different aspects of the problem become the focus of attention. This is partly arising from the different organisations of the education system in these countries, but also because people respond to opportunities for funding and research which are presented. For this reason we discuss 'Backgrounds and Emphases' in Chapter 3.

Chapter 4 contains summaries of the papers presented at the conference, in which initiatives taken in eight countries: The Netherlands, England and Wales, Sweden, Norway, W.-Germany, Portugal, the USA and Canada are described.

A survey of the deliberations of the Conference can be found in Chapter 5. After an introductory plenary session it was decided to divide into three separate working groups each discussing one of the following: teacher education, support for girls and women, and curriculum and teaching materials. These groups reported to plenary sessions towards the end of the conference, after which recommendations were discussed and formulated. These latter recommendations form the basis for Chapter 6, 'Future directions'.

At the end of the book (Chapter 7) a bibliography is included. Most of the items in it have been taken from the papers of the participants.

By this publication: 'Girls and Science and Technology', we hope to give a good idea of the shared experience of the GASAT Conference. The format of the book was agreed by the participants of GASAT Conference 1. We call it GASAT-1, for at the end of the 1981 conference one of the major recommendations made was to hold GASAT Conference 2 in May or June, 1983. The problem is an international one, it will not easily be solved and we need the support and inspiration of all who have a common concern to improve matters.

Who do we hope will read this book?
We have in mind all those with an interest in the things we have discussed, but especially those working at any level within education: men and women teachers in schools, student teachers and those involved in training them, young people and their parents, tutors in higher education, employers of young people and those with job training responsibility, examination boards and publishers, researchers, local education committees and governing bodies of schools and, not least, politicians and policy makers.

By this publication we hope to contribute to the process of removing the barriers which presently alienate women and girls from science and technology. We hope to create a climate in which they may participate in these fields at least as fully as do men and boys, contributing to our understanding of the natural world and to the shaping and control of the environment.

2. Opening address

Bernardijn ten Zeldam

You are here at the start of a GASAT conference about girls and women and science and technology. Its intention is to discuss the problems girls may meet in these fields and to compare the solutions you try to find in different countries.

I think this is a very good idea. Because there are some problems indeed. Also in the Netherlands. This will become clear when I tell you something about the Dutch educational situation. From age six to twelve all children go together to the same type of primary school (except for some who follow a special education). For secondary education there is not yet a comprehensive system. Most of the schools for general education are separated off from schools for vocational education. And vocational education includes schools for technical education, for domestic education, for agricultural education, for nautical education, and the like.

I need not explain that most of the population of technical schools consists of boys whereas the girls attend schools for domestic education. This situation makes those schools very sex-segregated: at an early stage the career options for both girls and boys are limited. We see equal numbers of girls and boys entering schools for general education at the age of twelve; there are even slightly more girls who do so.

So it seems as if problems will not arise in these schools. But what happens is - and I know that in many of the countries you come from the same thing occurs - that when it comes to subject choice the boys turn to mathematics and science and the girls to languages and social science. We even have a word to characterize the girls' options: girls take "pleasure packages", options which assure a pleasant stay in school but do not prepare for the real, serious things in life. Just let me give you one or two examples.

The pre-university school: In the classical stream the students have to take seven subjects for their final examination: mother tongue, one classical language, one modern foreign language, the other four are free options.

In 1977 90% of the boys took mathematics, 66% of the girls did so. For physics the difference is even greater: 64% of the boys and only 31% of the girls took this subject.

In the non-classical stream (mother tongue, one modern foreign language and five free options), the percentages are: mathematics 79% of the boys, 55% of the girls. Physics 58% of the boys, 24% of the girls.

But now look at the languages:

French in the classical stream: 23% of the boys, 52% of the girls, German 32% of the boys, 45% of the girls.

In the non-classical stream 24% of the boys did French, 60% of the girls. For German the percentages are: 48% boys, 73% girls. (Almost all students study English too).

I hope that these statistics make clear why this conference is going to deal with: "science, especially physics, and technology". Of all the science subjects, physics appears to form the greatest barrier for girls (the rank order is: biology - chemistry - physics). And the educational structure which often separates schools for technical education from schools for domestic education makes that only a very small number of girls will become oriented towards technical education.

In the universities 4% of the students of physics are girls. In the universities of technology only 2% of the students of physics are female.

Now that I have sketched the Dutch situation - and the situation in many Western countries is similar - let me raise three questions. The first is: why are girls so underrepresented in science (the same accounts for technology, but I won't repeat this every time). The second: why do we want to change this situation. The third: if so, what must we do in order to bring about that change.

I raised three questions. It's the second one I will concentrate upon.

I do not deal with the first question in great detail: why are girls so underrepresented in science. A lot of theories have been developed in order to explain this phenomenon. Biological, psychological, sociological theories. I do not

elaborate them here for two reasons.

I think that most of you know them very well. You are engaged in projects concerning girls and science or you are preparing them. You will have been puzzled by the same question: why? and you will have been searching - maybe - for definite answers.

But you may not have found them.

At least, that is what I suppose. For there are no definite answers. There are elements of truth in every theory.

The second question is: why do we want to change the situation. There are several reasons. They are valid for all countries, but I think the weight of the arguments may vary according to the country concerned. One argument has to do with the labour market. When industrial innovation is lagging behind because of a shortage of technically qualified personnel, when a country has to be built up and every woman and every man is needed, when there is a shortage of physics teachers .... then - and only then - we feel the need to train both girls and boys in technical and scientific subjects. This is what I call the macro-approach. The arguments are found in needs at the national level.

The other argument has to do with educational equity. Many interesting jobs require a technical or scientific training. Many schools for higher education ask for a previous science study; medicine for example. If we do not make sure that as many girls as boys study those subjects, we continue the situation that girls are given less educational opportunities.

I would like to call this the meso-level: the flaws of the educational system.

The third argument regards the girls themselves. This is what I call the micro-level. In the curriculum, we try to educate pupils in all areas of human life: language - communication - arts - science - crafts - sports. We want to enable students to develop their full potential. As long as we fail systematically in offering this wide range of options to girls, they are at a disadvantage and they are not given the

opportunity to experience the scientific way of thinking, of reasoning.

Here I think any policy maker, researcher or teacher is able to find reasons to change the present situation.

This brings me to my third major question: how can we effect change. Again, I cannot answer the question.

This will be your task. You have assembled here in order to exchange experiences. To explain what you have done, what has been successful and what not. I assume that at the end of this conference you will not have found the final answer: this is how to get all the girls into science education! I am afraid that there is no final answer. There are strategies and they may vary according to one's objective. Let me give you an example. If you are greatly interested in the labour market argument, you may find a quota system quite attractive. And if you are more interested in the development of the full potential of the individual girl, you may want to look at the contents of the curriculum.

After these general considerations concerning the specific theme of this GASAT conference, I should like to give you some information about the Dutch policy on educational opportunities for girls and boys.

In 1979 the Netherlands were the host country for the eleventh session of the Standing conference of European ministers of education, which dealt with "education and equality of opportunity for girls and women". Chairperson of that conference was the Dutch minister of education.
Not only in that conference, but also in his own department, minister Pais showed to be very involved in promoting educational opportunities for girls. He inspired a lot of projects that could start at different levels. With "a lot" I mean: almost a hundred were started or planned in 1979, when the Minister of Education published his "Sketch of a policy for emancipation in education and research".

Last summer elections were held and minister Van Kemenade succeeded minister Pais. He wants to continue the policy the former minister started, since he was more or less its originator.

Mr. Van Kemenade was minister of education before, and it was he who proposed "educational opportunities for girls" as a theme for the 1979 conference.

Most of the projects of the "Sketch" are now being executed and we find ourselves at quite a crucial moment: are the planned projects the right ones, will they work. What will be the effect of these plans? What barriers do we meet. What are the resistances.

Let me give you an example by mentioning some of the projects that are related to the topic you will be discussing this week.

One project aims at facilitating the entrance of girls in traditionally male professions by stimulating their participation in non-traditional apprenticeships. For example: the training for electrician, cabinet-maker, plumber, fitter, painter.

The problems girls meet are of various nature: they may feel lost at school, being the only girls among many boys; their previous schooling may have been insufficient; the employers may not be willing to engage girls .....

For all these obstacles solutions have been sought.

In this project, the girls receive theoretical instruction together in a girls' group. For the practical part of the training a number of girls will be placed in a concern together. In order to fill the gaps in the previous schooling of girls they receive extra courses, for example in science (remember what I told you at the beginning of this speech about the separation of technical and domestic education). Schools receive extra facilities in order to support the girls. And employers can get a special allowance from the Ministry of Social Affairs as an encouragement to employ girls.

This is the policy measure. Now how does the project work?

We can't say all our aims met immediate success. Many barriers have to be overcome by girls individually.

Not as many girls as we hoped do participate in the experiment. It is not always possible to place girls together: for much work is done in small teams, painting for example.

Daily-life technical experience turns out to be far less developed in girls than in boys. At the start of the courses many girls don't know how to handle a screwdriver, whereas this seldom is a problem for boys. Girls need extra schooling, especially in mathematics. As you see, a lot of problems. Yet, we aren't discouraged. Within the schools we see an increase of awareness about girls' problems. Schools learn to know the special situation of girls.

I think those of you who were involved in training programmes for women may have acquired similar experiences.

But our main problem is to find working places for the girls. Since youth unemployment is still rising, apprenticeships are difficult to find for both girls and boys.

Another measure in order to bring girls closer to technical education is the breaking down of barriers between schools for technical and schools for domestic education and to fuse them into one school for vocational education.

However, where this has happened, non-traditional choices don't yet occur often. Especially boys who take the so-called "female" subjects are rare. This seems quite understandable, when we consider the difference in values society attributes to female and male occupations. Yet, it is a matter of concern, because we should not concentrate solely on bringing girls into the male fields. For a more equal distribution of opportunities we should have both girls and boys participate in what we use to consider as "female" and "male" activities, without previous segregation by sex.

Even if most of our projects are only half on their way, we gain experience which I would like to share with you.

One is that one can work on educational opportunities at several levels. Most of you may be researchers, working in close cooperation with teachers on actions with a direct effect in the classroom. This school-focused approach is very useful,

especially for the topic concerned where so much depends on the attitude of the individual teacher.

However, being a policy maker, I should like to stress another experience, and that is the importance of a stimulating force by the ministry. I have already mentioned the great concern minister Pais had about bringing educational opportunities for girls and boys at the same level. The fact that the ministry of education was so actively involved in this has been an enormous stimulus for many people. Many initiatives have been taken. Teachers and organisations came to the ministry and asked for support, which they received. Also some educational work had to be done within the ministry itself, for at first not all policy makers were aware of the problems or willing to cooperate.

Now a network has been built in order to ensure that all measures taken are fitting in the general policy of equal educational opportunity.

To give an example: in future years the Open University will start in this country, distance education at the highest level. This university is expected to receive many female students. A decision had to be taken about the departments the university has to start with. The minister decided that there should be a science department in any case. His motivation was that many women would take this opportunity of adult education to fill in educational gaps.

Especially for women it is very important to get the opportunity to study subjects which give direct possibilities to enter careers with a real perspective instead of being confined again to the traditionally more "female" social sciences. This is not to say that studying social science does not offer a career perspective. It is the lack of real choice that is the problem.

It happens now more frequently that women ask for addition to their former education when they were young girls. In future, more women will ask for a vocational training after a period of homemaking. It is important for women that they get the opportunity to enter or to re-enter the labour force.

Concerning the education of girls, a change of attitude has to take place anywhere and everywhere, in the minds of the pupils, of the teachers, of society. An attitude that finds it only natural that women get a valid education and exercise a real profession anyhow. And not receive education "just in case" (where 'case' mostly is a divorce nowadays). Or in order to be able to understand their husbands better or to help their children with their homework.

Everywhere we see men in important careers and at the decision making places. It is time women prepare themselves to take their part of the decision power as well. Since a man's words still have more scientific weight than a woman's, it might be a good thing to quote a man now. But, in this conference, there might be some persons who are not quite unwilling to hear the opinion of a woman. It is therefore that I should like to quote a woman who was at the origin of the second feminist movement in the Netherlands, Joke Smit.

Her untimely death 19 September 1981 was a great loss for all of us.

In her opinion the most important thing for women is to change their own position, to fight for real power. As long as women don't have any power, actions for other political topics, like the fight for a healthy environment or against nuclear weapons are a waste of energy. The ultimate goal of feminism, she said, is redistribution of power, not for the mere power, but because power decides how reality is seen, not only through the eyes of the powerful, but also through the eyes of the powerless.

The aim of our education should be to change the attitudes of women and men concerning the traditional sex roles. This is a long term objective. Teaching science and technology to girls can be a step forward in that direction. And that is why we should teach girls science and technology; in order to enable them to take up their part of the decision places in this society.

3. Background and Emphases

As the participants came together for the first GASAT Conference, they were most conscious, perhaps, of what they had in common: a concern for the education of girls and women in science and technology. Their papers show a consciousness of the complexity of the problem, embedded, as it is, in the very fabric of society and in the identity of individuals. But they had chosen different aspects of the problem to study or within which to work towards change. As they prepared to share their several experiences of a common problem, they were urged to recognize the differences between them. These may arise from each person's unique perception of the problem, or from working within a different educational structure, or from a particular opportunity for development that has been seized.

There are, perhaps, three pressure groups that have contributed towards raising consciousness of the GASAT issues. The first may be called the 'shortage syndrome', for it is related to a shortage of skilled personnel (usually referred to as a manpower problem). If such a shortage is identified in any industrial or technological field, then governments, industrialists and professional bodies will turn to women as an 'untapped pool of ability'. Here the concern is for the job to be done and not for the women themselves. It is recognized, however, that at least some of the women 'out there' will be able to do the job effectively. This is an important pressure group, nevertheless, for it may command resources for research and development, but this is likely to be transient and support will be withdrawn if, and when, the shortage is made good. The drive to attract more women into engineering in the U.K. is an example of such a pressure.

The second pressure group is formed of science educators. Among these may be found some who look to girls and women merely to sustain numbers or to raise the level of achievement in their classes, but, in general, this group recognizes that science and technology are human endeavours and, as such, form a heritage for all children. To operate within these fields (rather than just

learning about them) contributes powerfully to the development of young people. Competence in science and technology opens job opportunities in many fields and an understanding of them is an essential preparation for citizens of democratic, technologically-based societies. The concern of this group of educators is for all children, and girls are seen as deprived if, for any reason, they do not participate as fully as do boys in science education. The power of the science educators lies in whatever influence they have over the science curriculum (and this may vary from one educational system to another) and in their participation in science teacher education. They may find support from governments or from research funding agencies of various kinds.

Finally, a strong and increasing pressure derives from the women's movement. This has, perhaps, achieved most so far in the United States, where legislation has been more effective than, say, in the United Kingdom, but many European nations are now committed to equality of opportunity for men and women. But, with or without the support of official statements, legislation and funding, individuals and groups of women are active in consciousness-raising and in developing strategies to bring about effective equality for women in power, status, personal development and responsibility within their own society. This pressure group may focus, at times, on the achievement of able women, for they will act as role models for others, but concern is for the development of all girls and women. The importance of the group goes without saying, for unless women themselves desire change, it will not come about.

Each of the participants will be located somewhere within these pressure groups or will have seized opportunities of support from them, which will have influenced the perspective of research undertaken or the direction of development work.

On the other hand, the education systems in which each participant works, may provide different problem areas and cause them to concentrate on one aspect rather than another. If experiences were to be shared effectively, it was necessary to recognize these

differences. It was suggested that this might sharpen perception of the problem and open up other possible ways of working.

At the Conference the participants gave a brief outline of the structure of the education system in their own country. This is expanded in the following notes, which also refer to the place of the sciences and technology within the school system.

Schooling in Countries Represented at the GASAT Conference

3 (i) The Netherlands

Compulsory Education starts from 1 August of the year in which a child reaches the age of 6 years 8 months and lasts 10 years. Any young person not continuing in full-time education after that must attend an educational or training institution for two days a week for the next year.

Although nursery schooling is not compulsory, most four- and five-year olds attend nursery school for at least part of the day during the week.

After six years in primary school children transfer to secondary education.

Forty percent proceed to a vocational school, the rest to some form of general education school. There are three types of course in the latter: junior general secondary *(mavo)*, lasting four years, senior general secondary *(havo)*, lasting five years, and pre-university *(vwo)*, a six-year course. Admissions to type of school are governed largely by assessment of the knowledge and intelligence displayed by pupils in their last years at primary school. Recent developments include the regarding of the first year of secondary education as 'the transitional class', which facilitates progression to the second year of more than one type of school, and the creating of single schools providing more than one type of course.

Vocational schools offer a general education, containing some natural science, for two years and concentrate on one or more technical or vocational courses for the last two years. These courses may be general technical, leading to apprentice-

ships in industry, home economics courses, agricultural courses, tradespeople's courses and commercial courses. Many of these are, at present, strongly sex stereotyped.

In general secondary schools biology, physics and chemistry are taught separately. The numbers of weekly lessons in the first three years of *mavo, havo* and *vwo* are given in table 3.

	biology	*physics*	*chemistry*
1st year	2	-	-
2nd year	2	2	-
3rd year	-	3	2

Table 3. The average number of weekly periods in the first three years of mavo, havo and vwo.

In the last years of these schools students have to make a choice. They can have no, one, two or all three of the subjects biology, physics, chemistry, up to the final examination.

Science plays rather an important role for following studies. More than 50% of professional studies require to have had physics to the end of mavo, havo, vwo schools.

As has been shown in table 1 (chapter 1) far more boys than girls choose physics for their final examination. As a consequence girls then can only make rather a limited choice in following studies.

Technology has no place, at present, in general secondary education - apart from rather small descriptions of applications of science -. *Technical education*, related to specific employment areas, is provided in the vocational schools only.

3 (ii) England and Wales

(NB Scotland and Northern Ireland have separate educational systems.)

The responsibility for education in England and Wales rests, largely, with Local Education Authorities. They provide

schools, Further Education Colleges and support Polytechnics, and in this are assisted by a 'rate-support' grant from the Government. The University System is separately organized.

Compulsory Education extends from 5 to 16 years. Some authorities provide nursery schools for children between the ages of 4 and 5, but this occurs infrequently at present. The years 5-11 constitute 'primary' education. This takes place in co-educational comprehensive schools, but considerable variation in organization may be found including middle schools (8-12 or 9-13 years). Classes are taught by general teachers, most of whom will have developed a 'special subject' during teacher education. This is rarely a science subject and, in the recent "Primary Survey' Report, Her Majesty's Inspectors expressed considerable disquiet about the inadequate experience primary school children are receiving in science and technology.

Most children proceed to comprehensive schools at 11+ (or later from middle schools), where general education is offered. The schools are largely co-educational, although some authorities retain a few single-sex schools, often in response to parental demand. Science (most commonly in some combined form) is almost invariably part of the curriculum for all children in the first two years of secondary education. In the third year the separate sciences are often presented instead and, in this year, pupils are usually required to choose a 'package' of subjects for study in years 4 and 5. Many of these will be presented for public examination at 16+, either for GCE 'O' level (for most academic pupils) or for the Certificate of Secondary Education, CSE, (which was intended for use with the top 60% of the ability range, but used for a wider range).English language and mathematics are usually compulsory subjects for study, but the three separate sciences are in competition with each other and with other forms of integrated or applied science in the options available.

One outcome is that only about 12% of all girls but 50% of all boys study physics after the age of 14 years. A subject called Design and Technology, based on workshops, is part of the secondary curriculum. It is increasingly becoming open to girls in years 1-3.

Education for 16-19 years is currently under debate. For some this is available in the 'Sixth Form' in schools, which traditionally offered two-year academic courses leading, since 1951, to GCE 'A' level examinations. Alternative, one-year courses are now being developed for less academic pupils. Some LEA's provide separate Sixth Form or Tertiary Colleges, and 'A' level courses are available in Further Education Colleges for those over the age of 16 years.

Entry to degree courses requires passes in at least two 'A' level subjects. As entry is competitive, some prestigious courses demand high grades.

3 (iii) Sweden

A new Curriculum Handbook is being introduced in the schools and will be completely in use from the autumn term of 1982.

There are nine years of compulsory schooling (ages 7-16) consisting of three stages: the low, the middle and the upper stage (3 years each). The natural sciences and technology must be taught to all children all through the compulsory school.

There are practical, vocationally orientated courses of ten week duration covering areas such as engineering and health care. Both boys and girls work within 'non-traditional' craft areas (e.g. with metal, wood and textiles).

A new element in the curriculum is 'free activities' in which the school, teachers, parents and children collaborate in choosing what to study.

In the upper stage the pupils have a choice between a "general course" in mathematics and an "advanced course".

After the compulsory school, the pupils choose either to start working or go to the "gymnasium-school", which includes theoretically as well as vocationally oriented streams.

3 (iv) Norway

The Norwegian school system is divided in two levels, governed by two laws:

1. From 1959 a mixed, comprehensive school for the age range 7-16 was compulsory. A common curriculum is centrally prescribed, both in terms of numbers of lessons for each subject as well as contents to be covered. Science is taught as a separate subject in the last three years. This is 'integrated' science, but it is often composed of easily defined separate parts of physics, chemistry and biology.

2. From 1975 a three-year school for the age range 16-19 was established; in principle this is open for all pupils. 50% of the population take the 'general' (i.e. theoretical) direction. The first year is common, and includes integrated science. The last two years are more specialized (humanities, social science, natural science) although the common core is substantial.

Most university courses are open to students who have completed the academic course, but some prestigious courses are closed, and they *all* require physics specialization from school.

For both levels there is one national curriculum, centrally controlled. Textbooks must be recognized by the Ministry of Church and Education.

3 (v) Federal Republic of Germany

In West Germany education is the responsibility of each State of the Federal Republic. Optional kindergartens are often available for children aged 3-5 years, but primary education is compulsory for ages 6-10 years. Some natural science is included in the curriculum at this stage. Their performance in primary school determines which of three types of secondary school the children will then attend. The Hauptschule, a five-year school, offers vocational courses; the Mittelschule, a six-year school, provides 'secondary level 1' courses; the Gymnasium is a nine-year school, with an academic emphasis, offering 'level 1' and 'level 2' courses. The first two years of these schools are regarded as 'orientation' and movement is possible from one to the other.

In level 1 courses all pupils study science. The point at which the sciences are presented as separate subjects varies from state to state. In some it is compulsory to choose one science,

in others pupils must choose two. The last chance to take up the study of physics is in the first semester of the eleventh grade (age 17), when pupils choose subjects for university admission. In the secondary level 2 courses (16-19) physics is the least popular of the sciences. "High performance' physics is studied on average by 30% of students and in one state 75% avoid physics. Only 10% of university physics students are women.

3 (vi) Portugal

In Portugal, coeducation was established in 1972 by a governmental decree. Children begin school at six years and follow a six grade primary curriculum which contains some natural science. When the sixth grade has been successfully completed families have the choice whether or not their children continue into secondary education. In the past separate technical/vocational and general education (academic) schools were available. Since 1978, a comprehensive secondary school has been established, with a unified curriculum for three years. After this, pupils may seek unskilled employment or continue for a further two years studying within one of five options. These are 'natural sciences and mathematics' (25% girls), 'Scientific and Technological' (5% girls), 'Economics and Social Studies' (59% girls), Visual Arts (44% girls) and 'Humanities' (67% girls).

The twelfth grade is used largely for university with 95% general education courses and only 5% vocational.

3 (vii) Canada

In Canada, education is in the hands of the Provinces. Schools are almost entirely co-educational and twelve years of schooling are generally provided. Elementary schools offer a unified curriculum to grade 8. In the last two years some specialist teaching may be available in the sciences. 'Industrial arts' and 'family studies' involve both boys and girls.

High schools are organized with three streams: academic, technical and commercial. The last is the most limiting, including little science, and is chosen frequently by girls. Science is often offered as integrated, environmental or earth science and students may graduate from high school with only one semester work in science.

Physics as such is available in grade 11 of an advanced programme leading to university entrance, chemistry is offered in grade 12 and courses at grade 13 containing all three separate sciences may be available in some Provinces.

3 (viii) United States of America

In the U.S. education is the responsibility of the separate states. A common pattern is for a state to offer kindergarten education, followed by a six-grade curriculum in primary or elementary schools. Nature study and/or introductory physical science usually occupy one block of time in the day's programme, but elementary teachers do not have a strong background in the physical sciences.

Grades 7 to 9 are available in junior high schools (although some states provide a two grade 'middle school'). One period per day (50 min.) is usually devoted to general science, which includes astronomy, biology, chemistry, geology and physics. Many high school teachers have only limited science in their training.

Grades 10-12 (or 9-12) form the curriculum of secondary or senior high schools. States make individual decisions about the length of compulsory schooling. Sixteen years is a common leaving age, but some require 18 years or a high school diploma. The completion of one course in science is the minimum requirement for the four years leading to a diploma; mathematics requirements are variable. The science course may be any laboratory science (biology, chemistry, physics, geology/earth science, environmental science, marine science, etc.). Most students, unless specialising in science, will choose a life science.

Providing a student has a strong mathematical background he or she may begin the study of physics at the age of 18 in a two-year community college, or even at a university.

4. Initiatives Taken to Resolve the GASAT Problem Reported by Participants to the Conference [1]

4(i) Initiatives in the Netherlands

Early in 1979 the Dutch Minister of Education in office at that time prepared a policy statement "Sketch of a policy for emancipation in education and research" which gave rise to over one hundred projects directed to improving equality of opportunity for women. In connection with this policy the Advisory Group for Teaching Materials was requested 'to construct guidelines which can be used by teachers to test teaching materials on their emancipation aspects and which authors and editors of textbooks can apply in writing and illustrating new material or in preparing reprints'.

In the HANDROVER project, set up in response to this request, Mottier has chosen to work in three areas: language, history and physics. The work in physics is being undertaken in collaboration with the MENT project (see later). Physics books have been examined to see if they form a negative factor for girls and to see how they may be improved. It was found that in the average Dutch physics textbook women are scarcely mentioned and if they are, they are represented in traditional female occupations or attitudes and not in scientific or professional roles outside the home. British studies (Taylor, 1979 and Walford, 1980) have found similar situations. Dumont (MENT project) also found that physics books contained little practical application of physics, although it is frequently claimed that textbooks would be improved by including more practical life situations, and that girls are more interested in applications of science.

In preparing guidelines it was decided that two kinds were appropriate: general ones referring to text and illustrations and ones specific to the subject content, in this case, physics. General guidelines recommend that illustrations must show persons, not only abstract images; they must show women and men in equal numbers and show both women and men in professional and in private, domestic situations. They

1) See *Contributions GASAT Conference 1981* (vol. 2), containing the full text of the conference-papers.

must not systematically depict women and men in sex-stereotyped positions (women:nurturing, passive; men: adventurous, active).

The same kind of statements may be made for the text so that the language in the text must not suggest that women are excluded.

In the actual state of research it is rather difficult to give guidelines specifically for physics textbooks; yet an attempt has to be made. It is suggested that physics is related to human interests and concerns and that the positive social implications of science are discussed.

The MENT project (TH Eindhoven) has been set up to reduce the disadvantage girls and young women have in the teaching and learning of physics and technology. In this project Dumont, Lensink and Raat are concentrating first on the 2nd and 3rd year of secondary education, when girls are 13-14 years old. At the end of the 3rd year of secondary education choices have to be made of subjects to follow in the years after that, up to the final examination. The percentage of girls now choosing physics at that moment, is less than 50% of the boys' numbers in vwo schools and only 25% or 20% of the boys' numbers in havo and mavo schools. Without physics at the end of the secondary school, the girls do not have entrance to many vocational schools of several levels and to many university courses in the field of technology, medical professions, mathematics, natural sciences and agricultural sciences. So a clear decision in the strategy of the MENT project is to focus attention on girls and physics and technology in the 2nd and 3rd year of secondary schools.

The MENT project is working in three ways: (1) making physics lessons more inviting to girls by changing their contents, (2) making teachers aware, or more aware, of the disadvantage girls suffer in these lessons, and helping the teachers change this for the better, (3) making the material (i.e. the physics textbooks) more friendly to girls.

There is need for specific material to be used in teacher-training, for initial training as well as in-service training, so that teachers may be prepared for non-sex-discriminating physics education. Such material is not available at present and so the MENT project is setting out to create some for itself. Video-tapes have been made of 'the pendulum experiment', showing that when a girl and a boy do a physics experiment together, the boy on the average carries out the activities in the experiment. Often the girl just watches what the boy is doing. The tapes are being used to stimulate discussion of the problem.

Verkerk (THE) is doing research on the topic 'practical examinations in physics'. In the Netherlands laboratory-based practical examinations in physics have been introduced recently in the last year of vwo schools. There is little experience in the Netherlands of organising these practical examinations. The aims of the study are to find methods for conducting practical examinations and methods for testing individual practical skills. It is planned to identify practical skills from the results of students in the various practical examinations and to distinguish these skills from those used in non-practical work, such as written paper and pencil tests.

So far no correlation has been found between various groups of practical skills and the two final examination results for physics. This means that this sort of practical examinations gives students fresh courage for good scores independent of their results up to that moment. This is the same for girls and boys. However, in general, boys seem to have better results in most parts of the practical examination and this is being looked at further.

The department of social science at the THE had identified as a problem the existence of so few female engineering students some time ago. Not only did few women enter engineering courses, but they dropped out more readily. Following developments in the USA, action programmes were developed and carried out. The evaluation of these was positive and so a more major project was undertaken. This involved the coordinator (de Raaff, THE)

organising a week's programme for young women entrants to the THE prior to their registering at the university. Through this it was hoped to prepare girls for the problems they might face as a very small minority in a predominantly male environment and to establish an informal, mutually supportive group amongst the girls themselves.

4 (ii) Initiatives in England and Wales

The small number of girls in physical science and technology classes at all levels of education in England and Wales has given rise for concern. Girls form the following percentage of entries to physics in public examinations: CSE 12%; GCE 'O' level 28%; GCE 'A' level 18% (see chapter 3 for explanation of these examinations). Candidates for university places require passes in at least two 'A' level subjects and it is very unlikely that any applicant to a physics or engineering course would be considered without an 'A' level pass in physics. Females form 12% of physics undergraduates and 6% in engineering.

As it is difficult to re-enter physical science classes at a later stage of education, attention has been focused on the choices pupils make at 13/14 years for or against the continued study of physics and chemistry. Ormerod has shown that able girls are more likely to have a positive attitude to physics and to choose to study it more often if they have been educated in a girls-only school rather than in a mixed school. He also showed that an appreciation of the social implications of science was an important factor in science choice for girls.

The girls from girls' schools in Harding's study of performance in 'O' level science examinations were more likely to obtain a 'pass' grade in any science subject than were girls from mixed schools. This was not so for boys. Her Majesty's Inspectors, in reporting a survey of secondary schools, suggest this effect of type of school on girls' choice of physics has disappeared with the conversion to comprehensive schools, but the number of girls' comprehensive schools in the survey was rather too small for reliable generalisations to be made.

Harding draws attention to two ideologies of girls' education which operated in the past. One, found largely in girls' grammar schools, was based on the determination to give girls an education equal to that of their brothers, and the other, operating for the 75-80% of girls who attended secondary modern schools, assumed that the major roles of women were those of wives, mothers and home-makers and educated them accordingly. In mixed comprehensive schools the expectation and achievement of girls will depend on how strongly sex-role stereotypes are transmitted.

The science H.M.I.s have case-studied twelve mixed schools in which girls choose the physical sciences in larger numbers than is normally so. Their report emphasizes the importance of positive encouragement for girls and the need to change the presentation of the physical sciences to make them less abstract and more relevant to human and social issues.

A major intervention study has been established in Manchester by Kelly and Whyte. The GIST project (Girls Into Science and Technology) aims at encouraging girls to study physical science and technology when these become optional. Barbara Smail, the Project Officer, attended the GASAT conference. Three early tasks were established for the project in its work in ten mixed comprehensive schools.

(i) They have worked with teachers to encourage them to question the existing patterns of choice and to appreciate the disadvantages that girls suffer compared to boys in studying science and technology. They found that most teachers were professionally committed to equality of opportunity, but assumed that boys and girls were different. Games and exercises have been used to change stereotypes, but some science teachers are not very keen on such techniques compared to teachers of the humanities.

(ii) They have developed test programmes for boys and girls to measure attitudes, skills and achievement. They have found that interests are more polarised than are abilities, with boys preferring topics about cars and space and girls those relating to the body and the natural world.

Boys were found to be more stereotyped than girls and they saw science as more masculine than girls did. This raises questions about the need to work with boys as well as girls to change girls' behaviour. One interesting 'natural experiment' occurred in one school where for twelve weeks half the 11-12 year olds (mixed classes) studied 'Craft' in the workshops and half Home Economics. Pre- and post-tests showed greater gains in spatial ability in both boys and girls who had had workshop experience, than in those following the Home Economics course.

(iii) They have set up a programme of visits to schools of women employed locally in science/engineering/craft work. These women were contacted through local industry and national advertisements. They attended half-day training sessions before visiting schools. These visits have had positive effects not only on boys' and girls' attitudes to women-in-science, but also on teachers. For greatest gains to occur it has been found that the boy : girl ratio in class groups is significant and that the teacher's help in articulating questions from the girls may be important. The briefing/training sessions were valuable in helping visitors to use appropriate language styles with pupils, although some problems were still encountered here. Women at the craft level of work were less likely to obtain time-off to visit schools than were the more senior personnel. The project is now expanding to work in the subject area of Craft, Design and Technology, because of the effect on spatial skills of workshop experience.

The Association for Science Education, with a membership of around 17,000 science teachers, has also been active in arousing concern for the problem. Its Girls and Physical Science Sub-committee has presented symposia at Annual Meetings and Jan Harding, as its chairperson, is frequently asked by local authority science advisers and others to contribute to in-service

meetings for teachers. The bulletin of the Association, 'Education in Science', has published accounts of strategies used by teachers to involve more girls in the study of physics and chemistry. These have indicated that change will occur only if it is strongly conveyed to girls (and their parents), using all kinds of techniques, that they are *expected* to study these subjects. One effective strategy involved the use of a tape/slide sequence advising girls of the importance of physics for many future jobs. The Department of Industry financed multiple copies of the sequence which has now been used in many schools.

The sub-committee is currently working with teachers to develop curriculum modules for third year pupils which aim to make physical science more attractive to girls and is preparing guidelines for published materials to remove sex bias.

Geoff Chivers, of Loughborough University, is convinced that one of the chief causes of so few girls possessing the right qualifications to enter engineering at different levels is the lack of association of careers to physical science studies. Influenced by American work and with support from the Engineering Industry Training Board, he initiated the 'INSIGHT' programme in 1979 at Loughborough. Girls who were studying appropriate courses in the Sixth Form and who were uncertain about a career choice in engineering were invited to spend a week at the University. Over 600 applications were received but only 45 places could be made available. The girls met in small groups led by professional women engineers, released for the week by their employers. Talks, discussions and career advice were arranged for them. They spent a day with engineers in industry finding out what their work entailed and visited relevant university departments. Of these girls 37 later entered undergraduate courses in engineering.

Discussion with girls who had participated in the INSIGHT programme revealed that most of them had not begun to think about a career in engineering until after 16; their choices at 13+ had not been informed by career advice. The teachers with career responsibility were mainly from arts or humanities

subjects, but even their science and mathematics teachers knew little about openings in industry. They confirmed the ease with which girls could drop out of physics at 13+.

The INSIGHT programme was extended in 1980 to nine universities and in 1981 to ten, when 400 girls participated (out of over 3,000 applications).

At Loughborough University, also, Susan Bullivant has encouraged women students to form a Women's Engineering Society, to facilitate mutual support in the largely male environment. This group has formed links with girls in the 13-15 age group in local schools. They prepare short talks and take along a tape/slide sequence giving information about careers in science and technology, and other career materials which are readily available but which few of the girls have seen. Science teachers in schools welcome these visits as they recognize that much work which has traditionally been performed by women may disappear. Moreover, they look to girls to maintain the numbers choosing their subject as rolls in school reduce in size. There is some disquiet, however, about the exclusion of boys from both programmes. The team at Loughborough acknowledge that the task of attracting girls into engineering may be made more difficult if boys participate, for most girls are unwilling to compete directly with boys in the context of physical science and technology where they feel at a disadvantage.

The whole question of the place of the sciences in the options offered to girls and boys at 14 years has now been raised by the A.S.E. as well as the Inspectorate. A 5-year project enquiring into science education has been undertaken jointly by the A.S.E., the Schools Council and the Department of Education and Science.

4 (iii) Initiatives in Sweden

Lena-Pia Lindholm, permanent secretary to the Committee of Equality at Lund University, reported studies of children's views on technology, research and the future. Swedish children express a heavy sense of pessimism and powerlessness; they fear

that the world will be taken over by computers and robots with an inescapable loss of human feeling. They are less interested in space exploration and more concerned about the environment, pollution, energy supplies and the threat of violence and war. They think that they have a right to affect their situation and their future, but they do not know how and they think they never will.

Lindholm sees as a major educational issue the question of how children can be activated to take a responsibility for their situation now and in the future. This is of special importance within an equality perspective as women have been most disadvantaged in influencing their condition. She reported boys as more frequently mentioning technological aspects of the future, while girls more often describe the everyday social and human situation (Jönsson, et al). Technology, she claims, may seem strange and frightening to many a girl, but by stimulating their interest in it, we may do three things: give them more power to influence their future, open up opportunities for personal careers and benefit society by using intellectual and emotional resources that have been almost invisible in the past.

She makes the following suggestions:

Teachers must recognize girls' rightful place in technology; the girls must feel that they are welcome and needed in the field.

Textbooks and materials used in discussion should display women and men equally, so that girls may perceive role models and boys get used to the sight of women in untraditional roles.

There must be discussions of the consequences of different applications of technology in relation to the kind of future boys and girls want, with both sexes equally involved. This may imply a problem-orientated approach with several teachers contributing across subject boundaries.

A project group within the High School of Technology in Lund has, for two years, with support from the University Committee for Equality, run a 3-day 'mini course' for girls to encourage those with a science background to enroll in technology courses in post-gymnasium education.

In the Swedish 9-year-school studies of natural science and technology will be compulsory throughout, from 1982. A special project has been launched to give in-service education for this to primary and middle school teachers. An experimental course in Lund brought together 10-12 year olds and researchers at the University. The theme was 'getting to know your town and its surroundings'. Themes such as 'The ground below', 'The houses in our town', 'Plants and trees in our town' and 'The air above' were used. Spontaneous questions from the children were encouraged and they made notes in 'research books'. Feedback from the experience has been very positive, with girls as interested as the boys (teachers have requested a special event for themselves!). Further researches into the resources within a local community which could be used to stimulate children's interests in science and technology, are planned.

4 (iv) Initiatives in Norway

The Centre for School Science at Oslo University acts as a link between schools and university, offering help and advice to teachers, running in-service courses and contributing to curriculum development. Svein Sjoberg and Svein Lie are currently working at the Centre within the 'Girls and Physics' project, supported by the Ministry for Church and Education. They report on preliminary findings which show that attitudes to the sciences are polarized by sex. For boys in a representative sample the relative popularity of the three sciences was: biology 52.9; chemistry 56.0; physics 42.8. The figures for girls were: biology 84.9; chemistry 30.0; physics 14.0. When science (which is taught as an integrated subject in the last three years of the 7-16 school) is compared for difficulty with other subjects twice as many girls as boys identified it as the most difficult (although girls' grades were slightly better than boys'!) and six times as many girls as boys mentioned science as the subject they would prefer to be spared from.

In Norway, attainment in mathematics and physics has developed an 'aura' of being an 'objective' criterion for future

educational success. By avoiding them girls cut themselves off from many interesting and prestigeous careers, not only in technology, but also in medicine, dentistry and veterinary science. The 'Girls and Physics' project is action-oriented, aiming to bring about change in the present situation by changing decisions made by girls (providing more information about careers and less-biased counselling) and changing the subject and classroom practice. It is argued that physics must change to become less strongly male-associated by de-stereotyping textbooks and representing males and females equally and by using examples to explain ideas in physics which appeal to girls' current experiences as well as those more familiar to boys. The project is carrying out surveys to ascertain more clearly how boys' and girls' interests and experiences relevant to learning physics do vary. It is concerned that even recently published texts contain strong stereotypes and this despite the official scrutiny of experts (who among other criteria look for sex bias) which is applied to a book before it may be recommended for school use.

But the presentation of physics, the project argues, must also change to show it as a process, a way of asking questions and finding out, rather than as a product, a collection of answers to standard questions. Physics should be shown to be an integral part of present culture, with physical theories possessing wide philosophical implications for society. Furthermore, many important and controversial decisions must be based on a combination of scientific understanding and value judgements. By stressing such aspects of physics it is hoped that girls will find it challenging and in turn might make a positive contribution to such a development. A number of teachers, many of them women, are anxious to contribute to the project.

4 (v) Initiatives in the Federal Republic of Germany

Lore Hoffmann reports that the issues of few girls in science and technology has only recently assumed prominence in Germany. No project or official programme has been started, but discussions take place and some initial enquiries have been made.

The percentages of students in high-level science courses in the 'Gymnasium' (where a science subject must be included) are biology 81%; chemistry 40%; and physics 33%. Only 6.7% of girls proceeding to university wish to study physics. Physics is an unpopular subject with both boys and girls. Reasons given for this are that it is boring, lacks application to technology, too little experimental work is included, the interests of students are not taken into account and the importance of physics for today's society is not emphasized enough.

Boys' and girls' interests in physics and biology subject matter were surveyed in 1974. In all topics in physics girls' interest levels were lower than boys' and declined from 6th Grade, while for boys the decline in interest began a year later. In biology the girls' interest level was reportedly higher than boys', except in zoology and ecology. Girls' interest in the environment and also in anthropology increased with age.

The enquiry into activities showed that boys preferred to discuss, reflect on, calculate, measure, give reasons for, examine and draw, while girls preferred to discuss (the only thing to increase with age), observe, explain and learn. Both boys and girls liked to experiment (unless it was in physics). Boys, predictably, had more experience in kits, construction toys and similar activities. The correlations between science-related, out of school activities and marks obtained for science in school were more significant for girls (0.79) than for boys (0.29).

Both boys and girls showed a general interest in technical equipment such as the camera, calculator, and telephone. Girls were interested in natural phenomena such as tides and echoes, boys in electrical phenomena and equipment (nuclear power plants, satellites, etc.). Physics teachers more correctly assessed the boys' interests than those of the girls.

Hoffmann points out there is room for improvement overall in science teaching, to relate it to the interests of boys and girls, to motivate both to study physics. But reform is needed also in textbooks that present stereotypes of behaviour, the expectation teachers and others have of girls, and in career

information, advice and counselling, so that girls know the consequences for work opportunities of avoiding physics and are made aware of the women who are already working in science and technology.

4 (vi) Initiatives in Portugal

Isabel Romao, who works in the 'Commission for Women's Condition', reported that although access to basic education had expanded for women in Portugal and that enquiries had shown that no legal discrimination against them existed in the schools, girls were still emerging less adequately prepared to take advantage of employment opportunities than were boys. Girls make their choices, she argues, from deeply assimilated expectations of their role in society. With help from Sweden she initiated a project called "Attitude changing on sex-roles" aimed at teachers and pupils in primary schools. The experiment in 5 pilot schools is being extended to Primary Teachers' Training Colleges countrywide and plans are being made to further extend it to other education levels.

Materials already developed include a booklet for discussion in primary schools entitled 'Girls and Boys, same world, same tasks', which shows children working together helping in the home and in more traditionally male tasks. Balloons have been produced carrying slogans 'Boys and girls, same world, same dreams', and 'Girls and Boys, same world, same games'. Plastic bags display the project symbol and the words 'Women and men, same world, same tasks' and 'Women and men, same world, same concerns'. Slide/tape and film sequences are being prepared for teacher education.

A Children's Literature Seminar was held in May 1981 to which writers, designers, publishers, journalists, children's programmes coordinators from the media and teachers from primary schools and Training Colleges were invited. The proceedings were widely reported in the press and in radio broadcasts.

Information and awareness campaigns have been mounted involving trade unions, cultural associations, youth organisations and so on, and contacts have been developed especially with

journalists and media programme controllers. All mass-media channels have been circulated with statements of project aims and samples of materials.

In Portugal, therefore, the much wider issue of sex-role stereotyping and its constraints on both men and women is being tackled. Its effect on women in science and technology will be interesting to see. But Portugal is unusual in another respect: although women formed only 3.7% of all registered engineers in 1977 and in 1976 contributed 15.3% to students on engineering courses, they formed 64.4% of the student group in chemical engineering.

4 (vii) Initiatives in the U.S.A.

In common with European countries women in America form only a small proportion of those working in science and technology. At bachelor level official reports show that women recipients formed the following percentages of total degrees awarded in different fields: behavioural and social sciences 37%; life sciences 38%; physical science 18%; engineering 7%.
At doctoral level the percentage of women was less at all levels, but showed a similar distribution from 25% in behavioural and social sciences to 3.5% in engineering.

Support for 'women in science' programmes has been available through the National Science Foundation as a result of funding by the Carter Administration. Participants of the GASAT conference were among those receiving grants in 1981/2.

Mary Anderson, of Arizona State University (A.S.U.), described two initiatives undertaken there: a re-entry programme for women at the masters level and support for girls and women already in the system. She bases arguments for such support on a model, proposed by Cobb, which claims that women are filtered out of science and technology by a system of filters which either do not exist for men or in which the pores are more permeable for the latter.

These filters are, briefly, the differential toys that boys and girls are given in pre-school years, the identifying of mathematics as a boy's subject that occurs first in elementary

school, the expectation that girls will choose only the minimum number of mathematics courses at high school, the lack of encouragement, even of girls with good mathematics, to major in science subjects which are perceived as male dominated, lack of encouragement also at graduate school where male supervisors may prefer to spend work time with other males and where acceptance of dissertation, publication and post-doctoral placements may depend on a supervisor who does not take seriously a woman's attempt to develop a career and, finally, the image of 'super-woman' projected for a female who attempts to run a home and a career in science or technology.

Anderson argues that lack of awareness of career openings in science and technology is a major contribution to the filtering process; career advice should be part of a self-development programme beginning in grade school and continuing through junior high school and high school years. She claims that several misconceptions need correcting:

(i) that engineers work with steel, concrete and things rather than with people;

(ii) that engineering is too strenuous for women;

(iii) that you have to like mathematics to tackle it and use it as a service subject;

(iv) that engineers don't have time for a social life.

Several strategies have been employed to encourage young women already in the system: a Scholastic Competition and Design Contest was instituted three years ago, supported by professional bodies and women high school students were encouraged to enter; two mathematics - science teacher workshops have been organized to provide information about college courses and career opportunities for women are stressed; High School Summer Institutes for minority group students in engineering have been held for four years with 'women' as one of four target groups and a Women in Science and Engineering network has been set up, with high school visits as a major part of their programme. As a result of these efforts women form 20% of undergraduate students in engineering departments of A.S.U.

A re-entry programme, directed by Mary Anderson, gives women who have been filtered out of the system, a second chance. Women with a first degree gained at least two years before, and who are unemployed or under-employed in terms of their potential, are recruited on to a masters of science degree, majoring in Industrial Engineering with concentrations on information systems and organization control. The entrants need not be science graduates, but must have one year of calculus; opportunities are available to acquire this. Fees are waived and paid, half-time industrial experience is provided.

Doris Simonis, working at the University of Iowa, has tackled the GASAT problem from two angles. She recognizes that women have lacked the encouragement their brothers have had to act independently and to explore their environment actively. This tends to establish in a woman a passive acceptance of the 'magic power' of science, of which they are consumers and 'victims'. To counter the resulting alienation she recommends the use of gentler and more familiar analogies than those normally used to explain physical phenomena. She has demonstrated the effectiveness of non-directive student-oriented laboratory work, with hands-on-action in bringing about shifts of girls' preferred modes of learning to more active, experimental initiatives.

Persuaded by Walter Scott Smith's research, from which he claimed that a perceived conflict of roles and *not* a perceived lack of ability discouraged girls from pursuing non-traditional careers, she organized a 'Women in Science Career Workshop' for high school and undergraduate women students. Eighteen women scientists described not only the challenges and joys of work, but also the way family and spouse responsibilities were accommodated and compromises made in the light of available time and energy. Although registrations were made in terms of preparation for disciplines and emphasized career-related information, post-evaluation showed that the greatest gain was in the rapport that developed between the young women and the professional scientists and engineers. As a result of this the Iowa Directory of Women in Science was compiled, listing women working at various

levels prepared to act as informal career counsellors and potential mentors of young women contemplating careers in science. A copy of the directory has been placed with each high school, college and junior college in Iowa.

Barbara Simpson, from Gustavus Adolphus College, Minnesota, argues that it is not financial reward that keeps women out of science and engineering in the U.S.A., for in these fields reports show that women command salaries comparable with and sometimes exceeding those of men. The more stereotyped as female women's occupations were, the more unfavourable were the salary comparisons made with equally qualified men. So, why so few women in science? It is not avoidance, for many students applying to Gustavus Adolphus (noted for its science) had not even considered such a career. In spite of a press for some time to change attitudes, women are still encouraged less than men to enter training programmes or to develop basic skills in science. More troubling, Simpson argues, is the outcome of some research on choice of a work companion: both men and women tended to avoid an image of a woman who demonstrated competence on career variables. To develop a career in science one has to be competent. What other qualities, therefore, do women need to be successful scientists or engineers?

Tangri's research showed that such women had successful women models available to them. Those committed to a career were significantly more autonomous than traditionally oriented women, but expressed more doubts about identity and the ability to succeed. Support from significant males in their lives, such as boy-friend, supervisor or laboratory assistant, was important. Kunds and Anderson investigated 12 women scientists, married and with families, who had been nominated as successful by male and female peers. Most had had parental support, half were first-born children and most were from small families. But the variable which emerged as most important in determining their success was an ability to cope emotionally with being reacted to as deviant.

Simpson predicts that large numbers of women will enter science only if we can make a rational case that being a

scientist does not place in jeopardy other successes that women need.

Ruth Ann Cade, of the University of Southern Mississippi, discussed several projects and research studies, which she and Robert Burr Cade have conducted, dealing with multi-phased programmes for recruiting southern women into science, based on extensive media use and interaction with suitable role models. Several factors which influence the design of an overall recruitment programme have been considered: determining the characteristics of the target group, developing contacts in regional high schools, conducting women in science career workshops and disseminating career information. She concludes that no one approach brings about sex parity in scientific careers. Most young women have been conditioned to believe that a career women loses her feminity and must sacrifice marriage and a family. This appears to be a major obstacle in their choice of science as a career. A most important factor in recruiting young women from high schools is the development of good relations with high school teachers. Most educational systems, especially on the secondary level, do not provide career education. Recruitment programmes which are carefully planned can yield results.

Don Low, of Orange Coast College, Costa Mesa, California, described the science career workshop project for women in science. Orange Coast College provides programmes of study in some 70 technical areas and offers a full range of studies for those transferring on to four-year colleges and universities. It caters for 33,000 students of whom just over half are women. Orange County has perhaps the greatest concentration of high technology industry of any county in the United States and among the thousands of scientists and engineers employed by these concerns are significant numbers of women. In 1980 the College contacted 1,000 local business and industrial companies, through their affirmative action officers, to identify women employed at the professional level in math/science related areas, and to request their help in allowing

junior college women to spend time with them informally and in their places of work. This 'shadowing' activity will be organized around a cross-referenced guide which will contain the names, brief biographies and position descriptions of women scientists and engineers participating in the programme.

It is planned to contact young women in the college through a one-day career workshop for Women in Science which will be publicized using multi-media channels including the District-owned TV station. The programme for the day, in February 1982, will contain presentations relating to such topics as math anxiety, career outlook for women, career search techniques, presentation of self and assertion. As a follow-up the young women will be offered participation in the shadowing programme, with initial contacts made through the project director.

Lucille Fink of Montclair State College, New Jersey, has also initiated a Career Advice Day for women in science to involve current students, unemployed women and minority women. She provided the GASAT Conference with an extensive bibliography on sex differences and female disadvantages and drew attention to the Fair Textbook Guide produced by the Publishers' Association in the U.S. She identifies the primary importance of the teacher in developing early interest in science and deplores the inadequate preparation of high school teachers in the sciences. An extensive in-service and pre-service training of teachers to correct this is advocated.

Carol Niznik recommended the use of games theory with girls as an effective way of providing for them the experiences, common to boys but normally eliminated for girls, which are positively related to achievement in science. These experiences she lists as: learning how things work by taking them apart and reassembling them; excelling at games; independence; reward for deflecting aggression into useful channels; mastering their own environment; self-visualization as strong, powerful and dominant; overestimating their own position in a 'toughness

hierarchy'; understanding that competence involves success in what they do and emergence as a leader; belief in their own ability to determine the outcome of events; visualizing of risk as a consequence of judgement based on experience; removal of fear as a first emotional reaction to attempts to evaluate outcomes; seeking a group identity and assertiveness. She claims that these formerly socially unacceptable behaviours in girls will encourage the persistence and determination required for pursuit of science and technology careers.

Deanna Chitayat provided the GASAT Conference with a somewhat different experience. She had directed the Project SEISMIC for the New York State Education Department. The goal of the project was to open up career options for females (as well as males) beyond those dictated by tradition. To achieve this three groups need to be educated: teachers, the students themselves and employers.

Few counsellors or teachers of either sex would describe themselves as sexist. Thus the sex-bias in interaction with students is often subtle and frequently unrecognized. To enable teachers to become more aware of their own attitudes, activities were arranged for small, leaderless groups, using print and video feed-in. Participants were challenged to examine sex differences in occupational choice, their own views of roles of men and women on the job and in the home, their own views of working women, and to evaluate counsellor's responses to students' career choices.

For secondary school students a sex-equity unit was developed. This consisted of a Curriculum Guide for teachers containing:

(i) introductory materials,
(ii) six fully developed lessons,
(iii) one copy of material which could be copied for class use,
(iv) video scripts,
(v) concise data on sex equity issues.

Two videotapes accompany the Guide. One presents 'Person-to-Person: Choices in a Changing World', in which stimulus 'dilemmas' designed to focus attention on sex equity issues are put forward to be 'solved' by the students. The other is entitled 'New on the Job' and is a 15-minute documentary featuring two women and one man who have made non-traditional career choices. These last were available for use with employers also.

4 (viii) Initiatives in Canada

In response to a wave of criticism in the late 1970's the Science Council of Canada initiated a broad study of the state of science education in elementary and high schools. The study sets out to achieve three major aims: to assemble data to describe the present state of science education, to undertake a historical analysis to provide a perspective for present trends and to stimulate active deliberation concerning future options for science education.

The strategy of *deliberative enquiry* has been adopted because the Council has no formal authority over education, which is a Provincial responsibility, and because such a mode of enquiry matches the complexity of the question, which is to determine the mode of education most fitting for a particular time and place.

The problem of encouraging girls to study science and technology has emerged as one of the issues to be deliberated. The Council supported a one-day workshop on the Science Education of Women in Canada in February, 1981. In attempting to assemble figures for the enrolment of girls in science classes (to demonstrate the present position) the first problem arose - many Provinces could not produce such statistics. Few had cared enough to find out. The issue had not been a problem. What data were available suggested a poor representation of girls in both physical science and mathematics.

In the workshop explanations of sex differences were explored and outcomes of a recent study commissioned by the British Columbia Ministry of Education were considered. These

recommended that curriculum developers should draw up sexism guidelines for materials, relate science to society and experiment with single sex groupings. In research schools with high and those with low science enrolment for girls should be compared and longitudinal studies of individual girls undertaken to assess the effect of various factors in developing an interest in science. Those responsible for in-service and initial teacher education should develop programmes for science and mathematics teachers and for career counsellors, focusing generally on increasing awareness of the problem and the importance of teacher influence.

Three chief ideas emerged from the workshop. The 'nobody cares' problem was the most urgent area of concern to be tackled first. Then in developing strategies for change the complexity of the problem should be recognized. There was no single simplistic solution; a great many factors operate to separate girls from science. Finally it was suggested that the difficulty experienced by researchers in pinpointing exact causes for the situation may arise from what is lacking in girls' experiences and education rather than from positive barriers. The proceedings of the workshop are edited by Janet Ferguson and published under the title 'Who turns the wheel?' and will contribute to the deliberative stage of the study along with other discussion papers.

Other data-collecting activities are underway: a survey of science teachers is taking place designed to illicit information from 10,000 teachers, nationwide, on factors relating to science education, including how teachers compare the attitudes and abilities of boys and girls. In addition, 8 detailed case-study observations and discussions will be organized in selected schools across Canada. One of the study's concerns will be to observe and analyse teachers' interactions with both male and female students.

5. Conference Deliberations

The conference started with the study of the educational systems of the various home countries of the participants. Although differing in many respects, they all had in common that fewer girls than boys study and choose to work in the physical sciences and technology. Chapter 3 has given a more detailed overview of the educational systems in which the problem arises.

For detailed discussion at the Conference three main topics were identified: teacher education, support activities for women and curriculum and teaching materials. These topics were discussed in small working groups. These groups generated many suggestions which are summarised below.

5 (i) Teacher education

The ideas of teachers about women and men will generally not be very different from the ideas of the average population. It is thus quite probable that the common stereotypes will be current among them. Research has shown this is indeed the case. So the first thing to do is to challenge the assumption of teachers and future teachers about girls and boys in education in general, and in science and technology in particular. An awareness raising process has to start. Social sciences have developed methods to promote such a process. However, science teachers, more used to what they see as the impersonal, unemotional ways of the natural sciences, may feel uncomfortable with these methods at first. It is, therefore, necessary to enter the discussion carefully, in order not to raise extra resistance.

Assumptions can be challenged by different means. The best thing is to confront people's opinions with the facts and to have them discuss the reasons for the differences found between boys and girls, men and women in science and technology. Discussion may be stimulated by questions.

A sequence of questions may be ordered:

1. How many women/girls are studying/working in the field of science and technology at different levels?

2. Why do we want more girls in science and technology?

3. How do we affect the situation?

With questions like these in mind, a sequence could be built which can be presented in a workshop:

(i) A quiz - guess statistics about real situations of women and men in occupations, girls in subjects at school, in textbooks etc. Then confront with the correct answers. The statistics of different countries may be given. If differences between answers and statistics arise, these may be discussed.

(ii) Respond individually to a list of "why teach science" reasons. Discuss in the group, defending and attacking positions until consensus is reached.

(iii) Respond to a list of qualities needed to study science.

(iv) Respond to male/female qualities.

(v) Finally discuss why the differences in (i) occur, why we may want to change the situation and how we can do so.

Each activity above should include stimulus material for discussion, such as video, slides, pictures, posters and printed materials. Care should be taken that the materials don't seem alien to the groups which use them. The lists should be generated by discussions with groups of teachers (possibly physics, chemistry, biology and technology teachers separately for (ii). As far as exchange is useful, these materials should be available internationally through a resource bank.

5 (ii) Support for women and girls

Many activities can be developed in order to support young women and women at different ages. Some suggestions are given for different age groups.

1. Intervention outside school

0-12 years

Outside the school children are confronted with various media which convey messages, most of which mirror society's stereotypes of male and female behaviour.

They may, however, be used to counter-balance negative effects. Non-sexist toys and games may be developed. Strong Parent-Teacher Associations can exert influence on manufacturers. Guidelines may help publishers of non-sexist childrens' books.
Both educational and non-educational television may play a role. Guidelines may be developed for tv-script writers to include young women in positive roles: in non-documentary programmes they should feature as strong competent heroines, and more may be shown of women scientists and the role of science in everyday life.

2. Intervention in school

6-9 years

We need to understand more clearly what concepts or experiences girls lack at this age which makes them feel uncomfortable with mathematics and science.
Within sports activities it is possible to develop skills, concepts and attitudes which foster involvement in science.

9-12 years

At this age, girls are already sensitive to role models. These should be presented to them in the form of a young woman studying science, or a practising woman scientist. In order to give girls more time and opportunity to develop manual skills which boys may already possess, boys and girls may be separated in science classes, and in Science clubs for girls only. Domestic projects should be encouraged for boys.

12-15 years

Activities that may be used:

- Science club for girls.
  This club may give assertiveness training and encourage a positive self-image as women competent with science and technology.

- Women in science visiting programme.
  Women working in science visit the schools to talk about their experience in the field. They may give career information.
- Career day.
  Exhibitions of women in working situations should be available with information on working in industry.
- Industry.
  A representative may be invited to speak in school. The girls make a trip to a particular industry.
- A network may be formed of supporting scientists, men and women.
  It is important that visitors to schools, as suggested above, should be aware of the nature of the problem they are addressing and should be briefed on how to approach young people.

3. University/College level
   - In order to support women students, peer groups may be formed.
   - Good non-sexist academic advice and counselling is necessary.
   - Career information must be given, not only about the content of jobs and how to apply for jobs for which suitable qualifications have been obtained, but how to plan for a developing career.
   - Role models and assertiveness training remain important.
   - Re-entry for women with science and non-science backgrounds must be facilitated.

5 (iii) Curriculum and teaching materials

It was recognized that most problems for girls arose in physics, but evidence had been presented which showed that physics was the least popular science for many boys, too. Discussion, therefore, focused on physics and technology.

1. The ideas of physics

   Topics in physics should be re-evaluated. More emphasis must be laid on the natural environment, energy and familiar technology. The choice of topics and their development are important.

   Examples of topics likely to be more interesting and appropriate for girls and boys (aged 11-15) than those presently used are:

   weather, earthquake, tides, topics from earth science; examples from the human body; examples from everyday life ("kitchen physics" and "bicycle physics").

   The sequence of development of topics should be from the familiar, natural phenomena, to the concepts, then to the formulae.

2. Social implications of science

   Some historical examples of scientific methods and contributions may be of value to draw attention to science as a creative human activity.

   Knowledge of the development of modern science and its consequences may be important for the understanding of its social benefits and risks.

   More balanced presentations should be made of concepts and applications of science; a wider range of examples of useful technology should be given.

   Controversies in applications of science, or in acceptance of theories which reflect social concerns (as in uses of atomic power and the creation - evolution contest in the U.S.) should be introduced for discussions to highlight the influence of science and technology on the welfare and the culture of human society and vice versa.

Teaching methods

Teachers should be made aware of

a. Tendencies to recognize and encourage boys more than girls by expecting more active cooperation, directing

more questions and/or calling more often on boys for responses.

b. The negative aspects of immediate "positive reinforcement" for girls. Encouragement and support for self-initiated inquiry and continuing investigations are essential to sustain interest and performance of girls as independent learners.
Because young women are accustomed to seeking social approval and thus avoid intellectual risk-taking, science teachers must make special efforts to be non-directive "coaches" rather than authoritarian directors in their classroom. As Jerome Kagan expressed it, "Boys figure the task; girls figure the teacher". The science teacher may have special responsibility to provide alternatives to these orientations.

c. Role-playing, discussions of controversial issues in applications of science and/or technology where each student must contribute an opinion and support it; brain-storming in groups where every student in turn contributes to problem-solving are strategies to be included in the teacher's repertoire.

d. Open-ended questions with no "right" answer should sometimes be used.
Questions (to be answered by experiential data) should never contain their own answer (e.g. Why is Material A a better insulator than Material B?).

e. Students should do activities themselves and be permitted to observe and explain phenomena that challenge their assumptions and expectations.

Classroom management

a. Group activities and team projects may require special arrangements if the teacher is aware of young women's less active involvement. Usually girls respond and perform better if paired with girls.

b. Expectations that all students will contribute to inquiries and discussions, will form opinions and offer hypotheses, should be reinforced by taking turns or sequencing reports arbitrarily, if necessary, to ensure that each student has opportunities to respond publicly and individually. If team consensus has been sought, assign a different "reporter" for each question.

c. Do not allow neatness and precision in written work to substitute for initiative, ideas and risk-taking.

d. Avoid liberal use of praise and criticism to manipulate behaviour. Strive to develop an atmosphere of openness to alternate explanations, diverse opinions, and fair comparisons.

e. Analogies should be used selectively and new ones developed that relate to phenomena noted as interesting and familiar to young women.
Youngsters can be taught to develop some analogies themselves, displaying understanding of key concepts.

f. Curriculum should include activities students can do individually or in same sex groups. Results of their activities should not be isolated bits of information but should be used as a 'hinge' to the next lesson or topic whenever possible.
Students should do activities, not just see pictures of other youngsters doing them. Reporting and discussing results of experiments orally, each person in turn, may be valuable experience.

g. "Fairness" of experimental set-ups (when used) should be emphasized. Encourage development of formal mental structure by always asking for adequate comparative data or "control".

h. When mathematical expression is important, spend time developing the formulae verbally and through data collected. Point out consistencies, relationships attended to.

Textbooks

1. Existing textbooks (and other teaching materials) must be examined to see whether they contain elements that disadvantage girls. All sexism must be removed.
2. Guidelines must be established for the production of new textbooks. They must deal with the content of instruction and with the language used, the illustrations, the examples, the illustrative texts.
3. Slides or pictures are needed which show men and women working in areas related to each science topic on the curriculum.
4. Research outcomes must be related to the production of textbooks. For example the topic raised by group 2: What concepts do girls lack (at a certain age) relating to science? Or a problem like this: What illustrations do appeal to girls? What makes a textbook attractive?

Recommendations

After the plenary discussion on the group reports, the conference discussed a set of recommendations. These are the recommendations that were agreed upon:

1. *Statistics* must separate the data of girls and boys in order to make different educational outcomes visible.

2. An *information network* must be built in order to facilitate communication between educators, scientists and researchers involved.
This purpose will be served best by an international clearing house, gathering information on:
   - (research) literature
   - resources
   - career information, etc.

3. *Teacher education* can play an effective role

- in pre-service education
- in in-service education

Both forms of education must be oriented towards the following objectives:

- make teachers aware of society's attitude towards (young) women;
- make teachers aware of their own attitude;
- make teachers aware of classroom interactions (teachers - students and students - students);
- make teachers aware of career opportunities for girls and boys in science;
- inform teachers about alternative strategies in science teaching.

These objectives cannot be fullfilled only by providing information. Other methodologies must be used too in order to bring about attitude change.

4. *Curriculum and teaching material* can contribute to promote girls' opportunities.

- Sex discrimination in teaching material and textbooks must be removed.
- Examples and illustrations in textbooks must be based on girls' experience too.

Science must be presented as an endeavour of women and men with historical, cultural, social and economic implications:

- The content of textbooks must not be too far from daily life. Presentation should not be abstract, formalized and theoretical, but rather concrete, connected with real life processes.
- Science lessons must pay attention to the social implications of science and technology. They must deal with the benefits of technological development, but also with the negative consequences, and/or controversial issues.
- Textbooks can use the biography of women scientists as an illustration of science as a human activity.
- Career materials must be developed for girls.

Teaching materials must include a variety of methods, for example problem solving, decision making, design, hands-on.

5. Informative, social and emotional *support* must be given to girls and young women. Some examples:

Informative support:
- information about consequences of subject choice
- information about (non-traditional) careers

Social support:
- positive image in media
- financial aid
- extra courses

Emotional support:
- role models
- female networks

6. More *research* is needed in order to know the problems and thereby change the situation.
Evaluation research into the effects of ongoing projects is important to form a body of knowledge as a basis for future experiences.
Longitudinal evaluation is essential in this context.

6. Future Directions

As we look to the future one of the few certainties we can assume is that of technological change, which will further affect employment, communications, transport and the cultural fabric of our lives. If we are committed to equality of opportunity and equality of status for men and women, it is essential that women as well as men are adequately prepared to contribute to the development and management of change through employment and decision-making and that neither sex is prevented by custom or deep-seated prejudice from developing imdividual potential. A good, basic education for girls in science and technology is an important pre-requisite for such a concept of equality. It was to facilitate this that the first GASAT Conference was convened.

A clear message from the conference is that girls' science and technology education cannot be treated in isolation, it is firmly embedded in three broad social and conceptual structures: the philosophy, aims and organisation of education, the practice of science and technology and the assumptions made about appropriate male and female behaviour. The interaction of these creates the current problems identified in the science education of girls.

Figure 1 presents a model of these interactions. The three major areas are represented as overlapping circles 1, 2 and 3. Interactions between 'education' (1) and 'science and technology' (2) give rise to science and technology curricular in schools (lozenge 4). Stereotypes of male and female behaviour (3) operating in the practice of science and technology (2) result in the image of science (lozenge 5) as impersonal, unemotional and male-dominated. Any sex differentiation in education (lozenge 6) arises from interactions of 'male and female stereotypes' (3) and the 'philosophy, aims and organisation of education (1). The central portion (7), common to all other areas, represents *girls' science and technology education.*

Initiatives designed to change the present character of this last area will be most effective if its central position within these interactions is recognized. 'Future directions' should therefore take this into account. The discussion that follows will make frequent reference to the model.

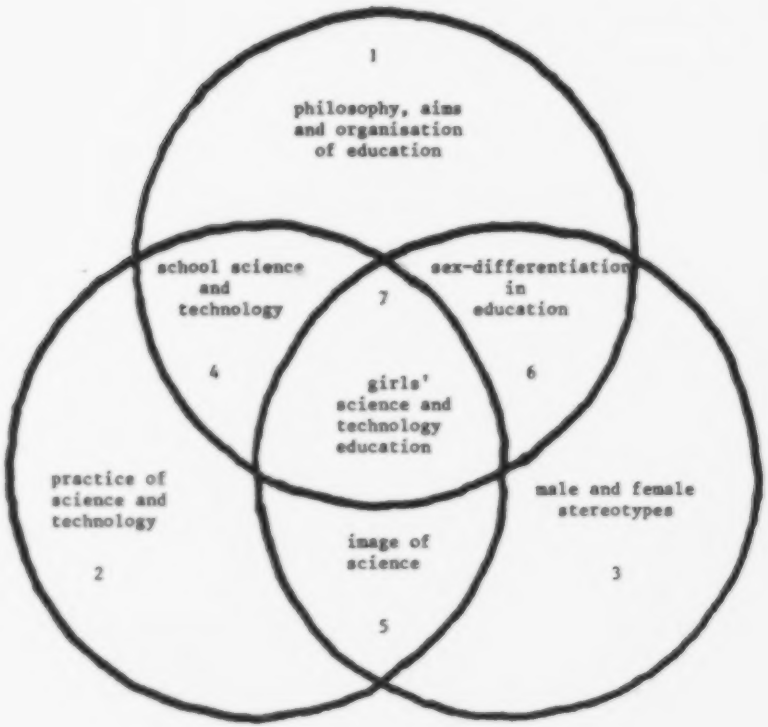

Figure 1. A model to illustrate the dependence of girls' education in science and technology on aspects of the education system, the practice of science and technology and the operation of sex-role stereotypes.

A useful point at which to start is observed sex-differentiation in education. It is important to know what differentiation does occur and to ask why it should be so. Therefore the collection and publication of data on differential participation of boys and girls in educational courses is essential both for initial questioning and subsequent monitoring of the situation.

This questioning should first be directed to the philosophy, aims and organisation of education. Is there evidence that different roles are assumed for girls and boys? Even where there are no explicit statements or structures which indicate this we should *examine the provision of choice* in the curriculum, for the operation of stereotypes on the process of choice at critical stages in adolescent development is just as effective a sorting mechanism as is allocation according to prescribed roles. When choice of subjects is provided the message that accompanies this is that it is quite acceptable to choose or reject among the constituents; they are of equal value. But when they open up different life chances we must be very sure that the young people understand what is involved and that they are of sufficient maturity to make the choice. This requires

(i) *sensitive, unbiased and on-going counselling and career education,*

(ii) *the possible delaying of choice to a later stage,* and

(iii) *the provision for re-entry to subject areas at a later time* for both boys and girls who may have chosen otherwise, possibly for some very good reason, at an earlier stage.

(i) *Career education* is becoming an accepted and formal part of the curriculum in the secondary schools of many nations. Specialist career teachers are being trained to organise classroom study, but it has been noted that classroom teachers (e.g. in physics) exert as much, and as we guess even more, influence on their pupils' views of themselves as competent to work in an area or of the opportunities which are available for employment if their subject area is chosen.

Two developments are needed here:

(a) all teachers of young adolescents need to be aware of their own assumptions about males and females and how these may operate in selectively encouraging or discouraging boys and girls to pursue the study of some topics or to choose certain careers. This is why GASAT Conference spent considerable time discussing developments for *teacher education* and made recommendations which are reported in Chapter 5;

(b) *for science teachers materials should be available* relating to all science topics which show real women and men working in science and technology. These should be cheaply, but attractively, produced and capable of being used during the course of a normal science lesson, without creating massive organisational problems. The format could be video, slide-tape or print. The use of such materials would locate school science more firmly in the real world, provide on-going career education, help to break down the stereotype of science as a male preserve and encourage more girls to participate in its study and practice.

(ii) The presenting of a much wider *choice of subjects* for study to pupils has accompanied the move, in several countries, from selective schools (where narrower courses considered appropriate to their selected group of pupils in them were offered) to comprehensive schools. The provision of choice was an attempt to cater for the wider spectrum of abilities, aptitudes and interests of pupils in the latter schools. But if certain subjects are chosen others are inevitably rejected. Counselling and the grouping of subjects may solve some problems, but experience has shown that what emerges for some is an unfortunately imbalanced, educational experience. For girls this has meant few continuing with physical science. It is argued that it is not timely to present pupils with important curricular choices in early adolescence, when they are only beginning to reassess themselves for adult roles. It may be more appropriate to expand, if possible, the core

of compulsory subjects and delay choices to a later stage.

(iii) The expectation underlying *re-entry provision* is essential at a time of rapid change, when a preparedness to train and retrain, to take new directions and to regard education as a life-long process is immensely valuable both to individuals and to the societies to which they belong. But this expectation will not develop unless it is explicit in the aims of education and opportunities to start afresh are built into the educational system. For women and girls in the present situation, re-entry to physical science and technology must be facilitated.

School science and technology exist in the overlap of educational aims and organisation and the practice of science and technology.

The question *why teach science?* may be answered at the philosophical level, making reference to 'a liberal education' or 'our cultural heritage'. But in practice physics and chemistry have been studied in schools largely by those who see their value in future careers; they have served an instrumental role. Biology is somewhat different; more boys as well as girls profess greater interest in biology in itself, although this is complicated by its 'easier' image and the perceived appropriateness it has for girls' future roles. Physics and chemistry are tailored more for the supposed needs of future scientists, so the pressure to establish the theoretical structure of the subject is greater. This discourages all but those who see themselves as future scientists or who realize that a lower career goal, too, requires a physics or chemistry qualification. Even a change to emphasize the process of science rather than the body of scientific knowledge has done little to change this. Girls, in particular, are discouraged from studying the physical sciences which appear to have little relevance for the human and social issues that are assuming importance for them.

But the argument for change in science curricula is not based on improving their attractiveness for girls. We believe that school science misrepresents science and technology in the world and that it should change to show science as a human endeavour, presenting intellectual and social challenge, and providing opportunity to improve the lot of peoples on this planet, but also equipping mankind with enormous potential for destruction. To achieve this some of the existing content should go and be replaced by subjects as e.g. *physics in society* [1]. It is anticipated that the outcome of such a revision will prove more attractive to girls and will provide a more appropriate education for citizens as well as for future scientists.

Although there has been considerable consensus in the past over what constitutes science education in schools, the same cannot be said about *technology* as a subject in the curriculum. Four views of it may currently be identified in schools: (i) equated with the development of technical skills, it is used for pupils of low academic potential, contributes nothing to the education of the able pupils and has low status in a hierarchy of school subjects; (ii) as 'applications of science' it may be tackled on to the end of a science topic. A particular technological operation, or set of operations, such as 'electronics' or 'pneumatics', may alternatively be used to structure parts of a science curriculum. The chief objective, however, revealed in assessment, is the associated science knowledge and pupils are rarely, themselves, involved with the technology except at a very elementary level in a school laboratory; (iii) as a powerful force affecting many aspects of our lives, it appears in 'science and society' programmes which are about technology and its implications and is classroom-based; (iv) as a process involving problem-identification, and solution search, design, realization and evaluation, it is environment- and workshop-based and the knowledge component is subsidiary to the problem-solving, decision-making process.

1) As an example we refer to Eijkelhof Harrie M.C., Egbert Boeker, Jan H. Raat, Niko J. Wijnbeek, *Physics in Society*. Amsterdam, 1981.

Currently girls may be involved equally with boys in (iii), the implications of technology, and it is hoped that a development of (ii) may attract more girls to the physical sciences (although the inclusion of complex technical systems in some materials offered to the 14-16 age range promises to do little for the girls). It may be that the extension of the last will benefit girls most in developing a self-image as competent and creating a will to contribute to technological development and the management of change but at present the male image of workshop-based courses discourages most girls from participating. Decisions about what constitutes technology in the school curriculum face most educational systems today. In Swedish schools 'technology' is a compulsory part of the curriculum for the nine years of schooling to 16 years. An experiment there has involved whole communities working with children in schools in developing responses to technological change and more positive attitudes to it [1]. This would seem to be a promising development.

The image of science and technology as a male domain, arising from interactions of male and female stereotypes in its practice, creates one of the most effective barriers to the participation of women and girls in scientific and technological activities. However, there *are* women working in these fields and we need to make them visible to girls and their advisers, whether they are teachers, parents or peers. Visual materials need to be available that show women at work in various levels of science and technology, not only for curricular use, as advised earlier, but for parents' meetings and career symposia. Some materials are already available and need to be publicized.

Women working in local industry are a resource which should be utilised in various ways. Some form of local organisation is required to coordinate such resources. This may be provided voluntarily by women's groups or by the local education authority. In some areas in England an 'Equal Opportunity' post has been created within the education authority.

Positive action to counter the male image of engineering has proved very effective in some USA universities and in the UK,

1) See Lena-Pia Lindholm in *Contributions GASAT Conference 1981*, p. 275

through the EITB 'Insight' programme [1], a considerable number of able girls have entered engineering degree courses. The next step is to invite these girls to talk to the younger girls still at school and to provide similar encouragement for the 'middle-ability' girls.

It is important that women already working within science and technology discuss the arrangements they make for home and child-care. Career breaks are not generally accepted within the companies employing women in such work. In some countries the medical profession, containing a higher proportion of women, has already initiated a programme for women doctors who wish to devote time to their children, to keep in touch with practice and training through part-time attachments with on-going work. One large bank in the UK is following suit. An important future development, as more young women are recruited into industry and science-based work, is to negotiate similar arrangements with their employers. It may be some time before the number of women in these positions will be large enough for pressure to develop naturally, as it were. There may be need for some kind of coordinated pressure group to be organized to enable concessions to be won.

Finally, as technological change accelerates and employment patterns alter we need to be vigilant that girls and women are not squeezed out of opportunities for experience and training that are offered, nor deprived of employment openings by the operation of stereotyped assumptions. We anticipate that future developments may exacerbate the GASAT problem. In many developing countries it has yet to be recognized and faced. The need for an international group providing mutual support and monitoring will continue for some time to come.

1) See G.E. Chivers in *Contributions GASAT Conference 1981*, p. 55

7. Bibliography

This list contains most of the publications cited by GASAT-participants in their contributions to the conference and judged to be of any relevance to the subject.

With a few exceptions, mainly publications in the English language have been listed.

Ahlgren, A., and Walberg, H.J. Changing Attitudes Towards Science Among Adolescents. Nature, 245, 173.

Aikenhead, Glen S. Science and Social Issues: Implications for Teaching. Science Council of Canada, 1980.

Alexander, K.L., and Eckland, B.K. Sex Differences in the Educational Attainment Process. American Sociological Review, 1974, 39, 668-682.

Anderson, J.V. Psychological determinants. In R.B. Kundsin (Ed.), Successful women in the sciences: an analysis of determinants. New York, New York Academy of Sciences, 1973.

Anderson, J.V. Sex Differences and Discrimination in Education. Worthington, Ohio, Charles A. Jones, 1973.

Association for Science Education (ASE). A.S.E., College Lange, Hatfield, Herts. 1981.

Bardwick, J. Psychology of Women: A Study of Bio-Cultural Conflicts. New York, Harper & Row, 1971.

Bardwick, J. Readings on the Psychology of Women. New York, Harper & Row, 1972.

Bart, P.B. Why women see the future differently from men. In: Toffler, A. (Ed.) Learning for tomorrow: The role of the future in education. New York, Vintage, 1974. (Pp. 33-57).

Baruch, G.K. Girls Who Perceive Themselves as Competent: Some Antecedents and Correlates. Psychology for Women Quarterly, 1976, 1, 38-49.

Baruch, R. The Achievement Motive in Women: Implications for Career Development. Journal of Personality and Social Psychology, 1967, 5, 260-267.

Bem, S.L. The Measurement of Psychological Androgyny. Journal of Consulting and Clinical Psychology, 1974, 42, pp. 155-162.

Born, G., und Euler, M. Physik in der Schule. Bild der Wissenschaft, 15 (2) 1978, 74-81.

Broverman, I.K., Vogel, S.R., Broverman, D.M., Clarkson, F.E., and Rosenkrantz, P.S. Sex Role Stereotypes: A Current Appraisal. Journal of Social Issues, 1972, 28, 59-78.

Brown, D.E., and Johnson, P.G. Education for the Talented in Math and Science. Bulletin 1952 No. 2, Wash. D.C., U.S. Gov't Printing Office, 1953.

Brown, L.H. Involvement of Students in Research. In: Proceedings of Women in Engineering. Beyond Recruitment Conference, Cornell University, Ithaca, New York, pp. 98-104, June 22-25, 1975.

Brush, L.R. Avoidance of Science and Stereotypes of Scientists. Journal of Research in Science Teaching, 1979, 16 No. 3, 237-241.

Cade, R.A., and Tullos, C.E. A Study of the Androgynous Characteristics of Women College Students. Journal of the Mississippi Academy of Science, Spring 1981. (In print)

Casserly, P.L. An Assessment of Factors Affecting Female Participation in Advance Placement Programs in Mathematics, Chemistry and Physics. (Grant No. GY-11325) Wash. D.C., National Science Foundation, July 1975.

Chiappetta, E.L., Shores, J.H., and Collette, A.T. Science Education Researchers' Perceptions of Skills Necessary for Secondary School Science Teachers. Journal of Research in Science Teaching, 1978, 15, 233-237.

Cobb, Jewell Plummer. Seven Filters Hampering Women in Science. U.S. Woman Engineer, pp. 1-3, February 1981.

Cole, Jonathan R. Women in Science. American Scientists, pp. 385-391, Volume 69. September 1981.

Connell, D.M., and Johnson, J.E. Relationship between Sex-Role Identification and Self-Esteem in Early Adolescents. Developmental Psychology, 1970, 3, 268.

Connolly, Terry, and Alan L. Porter. Women in Engineering: Recruitment and Retention. Engineering Education, May 1980.

Cotten, D.R., Evans, J.J., and Tseng, M.D. Relating Skill Acquisition to Science Classroom Teaching Behavior. Job Research in Science Teaching, 1978, 15, 187-195.

Crawford, C.G. Math Without Fear. New York, New Viewpoints/ Vision Books, Franklin Watts, 1980.

Crawford, M. Climbing the Ivy-Covered Walls. Ms Magazine, November 1978, pp. 61-63, pp. 91-94.

Curie, E. Madame Curie. translation Vincent Sheean, Doubleday, Doran & Co., Inc., Garden City, New York, 1938.

Dahlgren, A. Tva världar. Lund, Gleerup, 1977.

Dale, R.R. Mixed or Single-sex Schools. Vol. 3. Routledge and Kegan Paul, 1974.

Daniels, George. Science in American Society: A Social History. Alfred A. Knopf, New York, 1971, pp. 148-149.

Deaux, K., and Enswiller, T. Explanations of Successful Performance on Sex-Linked Tasks: What is Skill for the Male is Luck for the Female. Journal of Personality and Social Psychology, 1974, 29, 80-85.

Depner, C.E., and O'Leary, V.E. Understanding Female Careerism Fear of Success and New Directions. Sex Roles, 1976, 2, 259-268.

Dick and Jane as Victims: Sex Stereotyping in Children's Readers. Women on words, Princeton, N.J., 1970.

Ebinghaus, H. Physik wenig gefragt. Psychologische Blätter, 33, 1977, 477-478.

Eggleston, J.F., Galton, M.J., and Jones, M.E. Processes and Products of Science Teaching. London, Macmillan Ltd., 1976

Ekstrom, R.B. Barriers to women's participation in post-secondary education: a review of the literature. Paper presented at the meeting of the American Psychological Association, Honolulu, September, 1972.

Engineer's Council for Professional Development. Engineering - A Goal for Women. New York, New York.

Erickson, Gaalen, Lynda Erickson, and Sharon Haggerty. Gender and Mathematics/Science Education in Elementary and Secondary Schools. British Columbia Ministry of Education, 1980.

Ehrlick, A.C., and Lebold, W.K. Factors Influencing the Science career plans of women and minorities. Supplementary report of pole no. 101 of the Purdue Opinion Panel. Purdue University, West Lafayette, IN 47907, April 1977.

Fair Textbooks: A Resource Guide. United States Commission on Civil Rights Clearinghouse Publication 61, Washington D.C., 1979.

Ferguson, C. New Biology Examinations. University of London School Examinations Department, 1977.

Ferguson, J. (ed.) Who Turns the Wheel?: Proceedings of a Workshop on the Science Education of Women in Canada. Science Council of Canada, 1982.

Fox, L.H., Fennema, E., and Sherman, J. NIE Papers in Education and Work: No. 8 Women and Mathematics: Research Perspectives for Change. U.S. Dept. HEW, Washington D.C., 1977.

Franz, J. Wanted: More Women in Science and Technology. New York, American Physical Society, 1981.

Frazier, N., and Sadker, M. Sexism in School Society. New York, Harper and Row, 1973.

Gabel, David Rubba, P. Attitude Changes of Elementary Teachers According to the Curriculum Studied during Workshop Participation and Their Role as Model Science Teachers. Journal of Research in Science Teaching, Jan. 1979, 16, 19-24.

George, Donald. An Engineer's View of Science Education. Science Council of Canada, 1981.

Gillespie, Jane, and Weissman, Suzanne. New Mexico Network for Women in Science & Engineering. The University of New Mexico, Albuquerque, New Mexico, January 1981.

Girard, G.T. Impact of NSF Science Curriculum Projects: School, Science and Math, 79, 3-6.

Gjesme, T. Achievement-Related Motives and School Performance for Girls. Journal of Personality & Social Psychology, 1973, 26, 131-136.

Göttsching, A. Die Einstellung der Mädchen zum Physikunterricht und Möglichkeiten zu deren Veränderung. Wiss. Hausarbeit zur ersten Prüfung für das Lehramt an Realschulen. Kiel, 1975.

Hagen, R.I.,and Kahn, A. Discrimination against competent women. Journal of Applied Social Psychology, 1975, 5, 362-376.

Hager, W.R., and Thomson, W.J. Recruiting Women Engineering Students: Participation is Convincing. Engineering Education, April 1976.

Harding, J. Sex Differences in Examinations at 16+. Physics Education, 14 (1979) no. 5, 280-284.

Harragan, B. Lehan. Games Mother Never Taught You, Corporate Gamesmanship for Women. Warner Books Edition, Rawson Associates Publishers, Inc. 1977.

Harsanyi, J.C. Analysis of a Family of Two-Person Bargaining Games with Incomplete Information. International Journal of Game Theory, vol. 9, issue 2, pp. 65-89.

Haven, E.W. Factors Associated with the Selection of Advanced Academic Mathematics Courses by Girls in High Schools. Research Bulletin, 72:12, Princeton, N.J., Educational Testing Service, 1972.

Haynes, K.E., and F.Y. Phillips. Minimum Information Methods and Individual Choice: Applications to Linear and Loglinear Regression and Competitive Spatial Interaction Models. Proceedings of the International Congress on Applied Systems Research and Cybernetics, December, 1981.

Head, J.O. Personality and the Pursuit of Science. Studies in Science Education, 6, 1979.

Head, J.O. A Model to Link Personality Characteristics to a Preference for Science. European Journal of Science Education, 2, 1980.

Helson, R. Personality of Women with Imaginative and Artistic Interests: the Role of Masculinity, Originality and other Characteristics in Their Creativity. Journal of Personality, 1966, 34, 1-25.

Hennig, M., and A. Jardim. The Managerial Woman. Gulf and Western Publishers, 1977.

Hilmo, I., og Krogness, M.L. Lærebøker, en foreløpig rapport. Rapport 1 fra Jenter og fysikk, Skolelaboratoriet, Universitetet i Oslo, 1981.

Hinton, Kate. Women and Science. Manchester, SISCON-project, 1976.

Horner, M.S. Toward an Understanding of Achievement-Related Conflicts in Women. Journal of Social Issues, 1972, 28, 157-176.

International Journal of women's studies. Special issue: Woman and Science. Vol. 4 (1981) nr. 4.

Jönsson, A., Persson, M.-B.,and Tvingstedt, A.-L. The 'future' as seen by students in school: Explorations of unguided written compositions. Särtryck och smatryck (Malmö, Lärarhögskolan), Nr. 278, 1979.

Kagan, J. Acquisition and significance of sex-typing and sex-role identity. In M.L. Hoffman and L.W. Hoffman (Eds), Review of Child Development Research, Vol. 1, New York, Russell Sage, 1964.

Kaiser, H., und Münsgens, R. Untersuchungen zur Einstellung der Grundschüler zum naturwissenschaftlich-technischen Sachunterricht. SMG 7, 1979, 126-133.

Karplus, R. The Science Curriculum Improvement Study - A Report to the Piaget Conference. Journal of Research in Science Teaching. Sept. 1964.

Kelly, A. Girls and Science: An International Study of Sex Differences in School Science Achievement. Stockholm, Almquist & Wicksell, 1978.

Kelly, A. The Missing Half: Girls and Science Education. Manchester University Press, Manchester, 1981.

Kohlberg, L., and Zigler, E. The Impact of Cognitive Maturity on the Development of Sex-Role Attitudes in the Years 4 - 8. Genetic Psychology Monographs, 1967, 75, 89-165.

Kolata, G.B. Math and Sex: Are Girls Born with Less Ability? Science, 1980, 210, 1234-1235.

Krockover, G.H., and Malcolm, M.D. The Effects of the Science Curriculum Improvement Study Upon a Child's Attitude Towards Science. School Science and Math, 79, 575-584.

Kundsin, R.B., (Ed.) Successful women in the sciences: an analysis of determinants. Annals of the New York Academy of Sciences, 1973, 208.

Kutner, N.G., and Brogan, D. Sources of sex discrimination in educational systems: a conceptual analysis. Psychology of Women Quarterly, 1976, 1, 50-69.

Lantz, Alma. Strategies to Increase the Number of Women in Science. Comment on Vol. 4, No. 1. Signs: Journal of Women in Culture and Society. 1979, vol. 5, No. 1, pp. 186-189.

Lebold, W.K., and Richard, H. The 1974 Purdue Freshman Expectations. Department of Freshman Engineering, Purdue University, West Lafayette, Indiana, 47907, 1975.

Len, Eleanor Sin Yin. College Women in Engineering: Some Factors Influencing Their Career Choice. Ph.D. Dissertation, Arizona State University, May 1979.

Lindholm, L.-P. Pupils' attitudes to equality between the sexes. Lund, Liber, 1980.

Loring, Paula L. Special Needs of Women in Engineering. SWE Newsletter, pp. 1-6, April 1979.

Loring, R., and T. Wells. Breakthrough: Women into Management. Van Nostrand Reinhold Co., 1972.

Maccoby, E.D., and Jacklin, C.N. The psychology of sex differences. Stanford, Stanford University Press, 1974.

McMillan, J.H., and May, M.J. A Study of Factors Influencing Attitudes Toward Science of Junior High School Students. Journal of Research in Science Teaching, 1979, 16 No. 3, 217-111.

Majesty's, Her, Inspectors. Aspects of Secondary Education. London, HMSO, 1979.

Majesty's, Her, Inspectors. Curricular Differences for Boys and Girls. Education Survey 21. London, HMSO, 1975.

Majesty's, Her, Inspectors. Girls and Science. London, HMSO, 1980.

Maltzman, I., Brooks, L.O., Bogartz, W., and Summers, S. The Facilitation of Problem-Solving by Prior Exposure to Uncommon Responses. Journal of Experimental Psychology, 1958, 56, 399-406.

Mattfeld, J.A., and C.G. Van Aken (editors). Women and the Scientific Professions. (MIT Symposium on American Women in Science and Engineering) MIT Press, 1965, pp. 3-48.

Mednick, T.S., S.S. Tangri, and L.A. Hoffman (eds.) Women & Achievement. Washington D.C., Hemisphere, 1975.

Mischel, W. A Social Learning View of Sex Differences in Behavior. In E.E. Maccoby, ed. The Development of Sex Differences. Stanford, Cal., Stanford University Press, 1966.

Mittelacher, H.-D. Wahlverhalten der Schüler. In: Bericht über die 7. Tagung der Fachleiter in Physik an den Seminaren für Lehrerausbildung in der Bundesrepublik Deutschland einschliesslich des Landes Berlin 1979 in Recklinghausen. Schriften des Deutschen Vereins zur Förderung des mathematischen und naturwissenschaftlichen Unterrichts e.V. Heft 25, 1979, 11-24.

Moore, K.D., and Blankenship, J.W. Relationships between Science Teachers Needs and Selected Teacher Variables. Journal of Research in Science Teaching, 1978, 15, 513-518.

Moravscik, Michael J. Science Development. PASITAM, University of Indiana Press, Bloomington, 1974.

Mozans, H.J. Woman in Science. Cambridge, The MIT Press, 1974 (reprint of 1913).

Murphy, R. Sex Differences in Objective Test Performance. British Journal of Educational Psychology, 52, 213-219, 1982

Murphy, R. Sex Differences in Examination Results and Statistics. Paper given at Sex Differentiation and School Conference, Cambridge, 1980.

Nave-Herz, R. Das Angebot weiblicher Identifikationsmodelle in Lesebüchern. In: Materialien zur politischen Bildung, 4, 1978.

Newcomb, R. The Position of Women Engineers in the University Proceedings of the Woman's Day Symposium. Denton, Texas, 1980.

Newson, J. The Education of Girls. London, Faber, 1948.

Ogunyemi, E. The Effect of Different Sources of Verbalized Information on Performance at a Science-Related Cognitive Task. Journal of Research in Science Teaching, 1972, 9, 157-165.

Ormerod, M.B. a.o. Girls and physics education. Physics education 14 (1979) nr. 5, 271-277.

Ormerod, M.B. Pupils' Attitudes to Science: A Review of Research. Slough, NFER, 1975.

Ormerod, M.B. Subject Preference and Choice in Co-educational and Single-sex Secondary Schools. British Journal of Educational Psychology 45 (1975), 257-267.

Orpwood, Graham W.F. Deliberative Inquiry into Canadian Science Education. Journal of Curriculum Studies, 1980, Vol. 12, No. 4, p. 363.

Page, James E. A Canadian Context for Science Education, Science Council of Canada, 1979.

Pollack, B.L., and Little, L.K. Experimental Project in Physics Education or New Avenues for Women. Physics Teacher, 1973.

Putting it all together: A model program for Women Entering Engineering. Department of Freshman engineering, Purdue University, West Lafayette, Indiana 47907, 1978.

Roark, A.C. Women in Science: Unequal Pay, Unsold Ideas, and Sometimes Unhappy Marriages. The Chronicle of Higher Education, April 21, 1980, pp. 3-4.

Roby, P. Institutional barriers to women students in higher education. In: A.S. and A. Calderwood (Eds.) Academic women on the move. New York, Russell Sage, 1973.

Ross, Steven Sander. How Women are Changing Engineering. Graduating Engineer, pp. 25-27, February 1981.

Rossi, A.S. Barriers to the Career Choice of Engineering, Medicine or Science among American Women. In: J.M. Bardinski (ed.) Readings on the Psychology of Women. New York, Harper & Row, 1972, 72-82.

Rudnick, Diana Tarmy, and Ellen J. Wallach. Encouraging Women into Technical Careers: One successful Approach. Engineering Education, May 1979.

Saario, T.N., Jacklin, D.N., and Tittle, C.K. Sex Role Stereotyping in the Public Schools. Harvard Educational Review, 1973, 43, 386-416.

Schafer, A.T., and Gray, M.W. Sex and Mathematics. Science, 1981, 211 (Editorial)

Scholastic Teacher/Secondary Education. Special Issue: Women's Liberation and Schools, November 1971.

School Review, Special Issue: Women and Education. February 1972.

Shaffer, D.R., and Wegley, C. Success orientation and sex-role congruence as determinants of the attractiveness of competent women. Journal of Personality, 1974, 42, 586-600.

Sherman, J., and Denmark, F., eds. Psychology of Women: Future Directions for Research. New York, Psychological Dimensions, 1978.

Shinedling, M.M., and Pedersen, D.M. Effects of Sex of Teacher and Student on Children's Gain in Quantitative and Verbal Performance. Journal of Psychology, 1970, 76, 79-84.

Simonis, Doris. Stimulating Creativity: Learning by Analogy in Student-Structured Undergraduate Classes. Dissertation Abstracts International, 1978, Vol. 39A, No. 2, p. 799 (# 781-0384).

Simonis, Doris. Using Analogies for Creative Teaching in College Science Classes. Submitted to: Journal of Creative Behavior, 1981

Sjøberg, S., and Lie, S., Ideas about Force and Movement among Norwegian Pupils and Students. University of Oslo, Physics Report Series, 11, 1981.

Sjøberg, S. The Centre for School Science at Oslo University. European Journal of Science Education (to be published)

Sloan, M.E. (editor). IEEE Transactions on Education. Special Issue on Women in Engineering. February, 1975, Vol. E-18, no. 1.

Smith, E.P. ed. Achievement Related Motives. New York, Russell Sage, 1969.

Smith, Walter S. Science Education in the Affective Domain: The effect of a Self-Awareness Treatment on Career Choice of Talented High School Women. Paper presented at the National Convention of National Association for Research in Science Teaching, San Francisco, April 1976.

Sourcebook of Projects. Science Education Development and Research. National Science Foundation, Washington D.C., 1981.

South Australian Science Teachers Journal. Special Issue: Women and Science. December 1981.

Spence, J.T., and Helmreich, R. Masculinity and Femininity: Their Psychological Dimensions, Correlates and Antecedents. Austin, Texas, University of Texas Press, 1978.

Spence, J.T., Helmreich, R., and Stapp, J. Likability, sex-role congruence of interest, and competence: it all depends on how you ask. Journal of Applied Social Psychology, 1975 5, 93-109.

Sprowle, Betty A., and Mathis, Harold F. Recruiting and Keeping Women Engineering Students: An Agenda for Action. Engineering Education, April 1976.

Stacey, J., Bereaud, S., and Daniels, J., eds. And Jill Came Tumbling After: Sexism in American Education. New York, Dell, 1974.

Stake, J.E. Effect of Probability of Forthcoming Success on Sex Differences in Goal Setting: A Test of Fear of Success Hypothesis. Journal of Consulting & Clinical Psychology, 1976, 44, 444-448.

Tack, W.H. Cooperative Conflict Resolution: A Formal Approach and Some Empirical Results. In: Ernst D. Lantermann, Hubert Feger (editors) Similarity and Choice. Hans Huber Publishers, Bern, Stuttgart, Vienna, 1980, pp. 290-326.

Tack, W.H. Domination in Experiments on Cooperative Games Without Side Payments. Proceedings of the International Congress on Applied Systems Research and Cybernetics, December, 1981.

Tangri, S.S. Determinants of occupational role innovation among college women. Journal of Social Issues, 1972, 28, 177-199.

Taylor, J. Sexist bias in physics textbooks. Physics education 14 (1979) nr. 5, 277-280.

Tobias, S. Overcoming Math Anxiety. New York, W.W. Norton & Co. Inc., 1978.

Today's Education, Special Issue: The Schools and Sex Role Stereotyping. December, 1972.

Todt, E., Arbinger, R., Seits, H., und Wildgrube, W. Bericht über den 1. Teil des von der Stiftung Volkswagenwerk finanzierten Untersuchungsprojektes: Universität Giessen.

1974. Untersuchungen über die Motivation zur Beschäftigung mit naturwissenschaftlichen Problemen (Sekundarstufe I: Klassenstufe 5-9) (Biologie und Physik).

Tresemer, D. The Cumulative Record of Research on 'Fear of Success'. Sex Roles, 1976, 2, 217-36.

Twenty Years of Science and Math Curriculum Development: The Tenth Report of the International Clearinghouse on Science and Math Curricular Developments. J.D. Lockhard, ed., 1977, College Park, Maryland, Science Teaching Center, University of Maryland.

Unger, R.K. Female and Male; Psychological Perspectives. New York, Harper & Row, 1979.

Unger, R.K., and Denmark, F., eds. Woman: Dependent or Independent Variable? New York, Psychological Dimensions, 1975.

Wellesley-Wesleyan Training Program. Math Avoidance and Math Anxiety in College Age Students and Adults. Wesleyan University, Middletown, Conn., 1977.

Wells, Paula B. Needed: Information and Confidence. In: SWE Newsletter, p. 2, April, 1979.

Weltner, K. u.a. Das Interesse von Jungen und Mädchen an Physik und Technik. NiU-P/C, 27, 1979, 321-325.

Weltner, K. Wahlverhalten der Oberschüler in den mathematisch-naturwissenschaftlichen Fächern. NiU-P/C, 27, 1979, 102-104.

Weltner, K. u.a. Interest of Intermediate-level Secondary Students in Physics and Technology. European Journal of Science Education 2, 1980, 183-189.

Willenbacher, P. Zum Wahlverhalten der Schüler bezüglich des Faches Physik in der neugestalteten gymnasialen Oberstufe. PU, 15 (3) 1981, 57-61.

Wilson, J., and Rutan, P. Career Education: An Open Door Policy. Bloomington, Indiana, Phi Delta Kappa Ed. Foundation, 1977.

Winchel, R., Penner, D., and Shaver, P. Impact of Coeducation on Fear of Success Imagery. Journal of Education Psychology, 1974, 66, 726-730.

Wittig, M.A. Sex Differences in Intellectual Functioning: How Much of a Difference Genes Make? Sex Roles, 1976, 2, 63-74.

Wittig, M.A., and Peterson, A.C., eds. Sex Related Differences in Cognitive Functioning: Developmental Issues. New York, Academic Press, 1978.

Women in Engineering. College of Engineering. The University of New Mexico, Albuquerque, New Mexico, March, 1980.

Women's Studies International Quarterly. Special Issue: Women, technology and innovation. Vol. 4 (1981) nr. 3.

the GIRST conferences

on

girls and science and technology

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Abstract

The project on GASAT=Girls and Science and Technology consists of bringing together people involved in research and development projects in order to increase the participation of girls and women in science and technology education, by organising international conferences.

The initiative was taken in The Netherlands where the first conference was organised in 1981 in Eindhoven.

The second GASAT-conference took place in Oslo, Norway, in 1983.

The third conference took place in London, England.

The fourth conference will be organised in 1987 in the USA by the University of Michigan, Ann Arbor.

The policy on equal opportunities for women in education in The Netherlands started in 1979. Although there exists formal equality in the schoolsystem, it soon appeared that young women were receiving less schooling in different types of education than young men. They were far beyond men especially in science education and in the vocational education for traditionally male fields, such as technical education.
To ameliorate this situation, several projects were started in science and technology.
The same pattern as in The Netherlands could be found in different other countries, which had also taken initiatives to stimulate science and technology education.
In Europe, the United Kingdom and the Scandinavian countries were active. The United States had already a longer tradition in promoting sex equality in education.
In order to bring together all countries interested, to exchange experiences and to stimulate new initiatives, plans were made to organise an international conference. This became the GASAT project on Girls and Science and Technology.

GASAT-1 (Eindhoven, The Netherlands, 1981)

The first GASAT-conference, organised with the support of the Dutch Ministry of Education, took place in Eindhoven, The Netherlands, in november 1981. Its organisers were Jan Raat, Eindhoven University of Technology (doing research in the MENT-project on girls, physics and technology), Ilja Mottier, Ministry of Education (doing research in the HANDROVER-project on sexstereotyping in textbooks), with the international cooperation of Jan Harding from Chelsea College in London.
Thirty participants from seven nationalities were present: United States, Canada, United Kingdom, Norway, Sweden, Federal Republic of Germany, Portugal and The Netherlands.
Most of the contributions dealt with science education, especially physics. Papers were distributed before the conference took place, in order to enable the immediate set up of workshops.
Three main topics were identified: teacher education, support of women, and curriculum and teaching material.

Teacher education
This group suggested a number of activities appropriate to influence teacher's assumptions about and attitudes towards girls in science and technology. Possible challenge activities:
- put questions like
  - why teach science?
  - what qualities do males and females possess?
- organise discussion in groups
- provide stimulus material for discussion, such as video, slides, posters, printed materials.

The group also suggested topics for research, especially longitudinal case studies of intervention, evaluation of strategies, interaction.

Support for women

This group has considered the needs of young women and of women of different ages and has formulated a great number of support activities. Some examples: non-sexist toys and games, non-sexist books, women scientists as role models, field trips to labs and industry, science clubs, career information, network.

Curriculum and teaching material

The group concentrated on proposals for change and new topics that could be introduced in the curriculum.
Methods of teaching were discussed, with great emphasis on favouring active inquiry in girls, in teaching them to take risks, even without praise from teachers (although not everyone agreed on this strategy).

Recommendations

The conference agreed upon the following recommendations:
1. Statistics must separate the data of girls and boys in order to make different educational outcomes visible.
2. An informal network must be built in order to facilitate communication between educators, scientists and researchers involved.
3. Teacher education can play an effective role in making teachers aware of the attitudes of society and their own.
4. Curriculum and teching material can contribute to promote girls' opportunities.
5. Informative, social and emotional support must be given to girls and young women.
6. More research is needed in order to know the problems and thereby change the situation. Essential in this context is longitudinal evaluation research.

The first conference decided to organise a second one, to be held in Norway.

GASAT-2 (Oslo, Norway, 1983)

The second GASAT-conference was indeed organised by the Norwegian researchers of the 'Girls and physics' project of the University of Oslo, Svein Lei and Svein Sjoberg. It was held in september 1983.
This second conference received sixty participants. New coming countries: Denmark and Italy. Papers were sent in under four headings: sex

stereotypes and interactions, curriculum, intervention programmes and teacher education. These headings also determined the structure of the conference, where again people read the papers in advance. This conference showed a notable progress in both the quantity and the quality of research and intervention with respect to science and technology education.

Sex stereotyping

Science itself is stereotyped as male. This is because more men currently work in it. Moreover, male experience is treated as the norm in science and female experience is considered deviant. It is important to understand sex differences as historical products, rather than natural phenomena. It will not be easy to challenge the association between masculinity and science. Already at an early age pupils make this connection.
It is necessary to reduce sex differentiation between men and women in science and technology.
Intervention strategies must not be built on the assumption that girls and women are deficient and need to change. They must take into account female experience, without introducing again stereotypes about women as irrational, sentimental and incompetent.

Classroom interaction

Special attention was given to classroom interaction studies because of the great importance of the attitude and behaviour of science teachers in the classroom. Involving science teachers themselves in carrying out classroom interaction studies has proven an effective way of convincing them that there is a problem of sex bias in science teaching, without reinforcing their resistance against change.

Curriculum

Curriculum content is often more oriented towards the interests of boys. These are: engins, big forces (vulcanoes, earthquakes, planets), technical aspects. Girls are more interested in: the human body, health, the weather, esthetic aspects, social implications. The different interests are partly

caused by different experiences. More girls than boys have experience in the care of plants and animals; more boys than girls have experience in using mechanical objects, construction toys, tools, instruments, car maintenance.
Science education in the past has been related too closely to boys' present interests, past experiences and a masculine way of looking at the world.

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Intervention strategies

In certain countries and at certain times (for example during wars) interventions have proved successful. It is therefore important to study them. Successful interventions provide powerful examples to persuade people that girls and women can succeed in science and technology.
But it is unfair to encourage girls to study or work in such fields without offering support to help them cope with problems arising. Different types of intervention can be developed: interventions which involve changes in the schoolsystem, which use the school only as a place to find groups of girls, or which bypass the schoolsystem completely and work directly with girls and parents in clubs or in the home.
Allll types of intervention are worthy of investigation, and the most effective can be used concurrently. School based interventions can be reinforced by attitude changing initiatives outside school.

Teacher education

Both pre-service and in-service teacher training are important tools to raise awareness of teachers. For both types of training, curricula are still lacking.
The way of approaching the teachers is important. When we talk about discrimination and consciously sexist behaviour, and try to challenge these sexist ideas and undermine them, in most cases the result will be that more resistance is created. When we talk about stereotyping and unintended differential treatment, and when we try to inform teachers, analyse attitudes, offer practical help, the result will be a change of behaviour.
We must try to pull the discussion from the personal to the professional. Teachers may keep some of their personal beliefs, but should change their professional attitudes. Science teache.. are not interested in psychological data. They want to know what to do.

Apart from these topics, the conference discussed a number of *fundamental themes*:

1. Why do we want more girls in science?
   There was a strong feeling that knowledge of science is fundamental to an understanding of the technological world in which we live, and that all citizens must have access to that understanding. Some doubt was expressed as to whether the participation of more women in science would automatically change the nature of science and ensure that social issues are treated more seriously.
2. Are we talking about inequality or oppression?
   Most participants agreed on the assumption that the problem of women in science is an aspect of women's oppression, and of male power over females. But most of the strategies in education operate as though it were a question of inequality, which can be solved bij good will and education.

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3. What changes do we want?
   Changes are necessary in girls, in boys, in school science, in science and in society. We don't have to work simultaneously on all of them, but we have to keep the total picture in mind.
4. What research do we need?
   We need more research on classroom interaction; more about the ways in which subject choices are made, more about evaluating interventions.

The conference recommended that the third GASAT-conference should be organised in England.

GASAT-3 (London, United Kingdom, 1985)

The third GASAT-conference took place in London in april 1985 and was organised by Jan Harding from Chelsea College in London, supervisor of the GATE-project on girls and technology education. The year 1984 had been WISE-year in England, a year to attract "Women into science and engineering". GASAT-3 also concentrated more on technology.
Papers were requested under three main headings:

1. Technology education
   objectives, values, forms and participation of girls and boys
2. Strategies for change to a less sex differentiated science and technology
   - the development of strategies to tackle fundamental causes
   - evaluation of strategies for change
3. Women, society, science and technology
   experiences, values and visions for the future

The conference received over a hundred participants from more than twenty countries. For the first time developing countries, especially from Africa, were present. This shows how the 'GASAT-idea' is spreading all over the world.
Where developing countries may have problems in providing education to both boys and girls, at the same time they try to observe in the industrialised countries how they can avoid certain pitfalls.

Technology education

There is still much to be done to involve girls in technology. On the one hand, girls must be encouraged to go into technical education, on the other hand technology must become part of the curriculum for all students, in general education too. This means a challenge to the concept of technology, that, perhaps even more than science, has been defined as all male.
These last years in many countries, a big part of technology has become 'information technology'. The same questions occur: how do we keep enough women in the computer race, and: how does the logic of computers fit with the reasoning and the creativity of women. Questions which are especially raised in Denmark.

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Technology education benefits of the attention of those states who feel that they must raise their educational standards in front of a fast changing labour market with a demand for highly skilled technical personnel, in order to cope with economic decline. This asks for the schooling of everyone and for the use of all the potential in the population.
The United States have considerably increased the percentage of female engineering students, which is around 25% now. Other countries, like The Netherlands, still have very low numbers (around 5 %).
Career orientation, counselling and the possibility of hands on activities to acquire practical skills count among successful strategies.

Strategies for change

With such a big number of conference participants, numerous projects report on intervention strategies. In the United States evaluation of the science programmes has pointed out the importance of early mathematics, since math is really the critical filter for studies in science and engineering.
Teacher training must include specific attention to equity, in order to make schools serve as positive change agents.
Several researchers raise fundamental questions such as:
- do women have a different cognitive style;
- do women and men acquire concepts in the same way and in the same order;
- what is the relationship between our concept of feminity and our strategies in science;
- can feminity and masculinity be seen as indirect ways of expressing subordination and dominance.

The development of attitudes towards science and technology is measured by different researchers. This may enable us to state at what moment things go really wrong for girls. Although there is much reporting about sexist practices in Kindergarten, it may be assumed that really negative attitudes only develop around puberty.

Values and visions for the future

Discussions about values come close to the fundamental questions raised in connection with other topics.
We have passed the stage where women's position in science is defined as deficient with respect to men's, and where the solution is to bring women at the level of men.
Women have begun to challenge the power positions. They thus challenge the curriculum content. They start to define their own values and are now struggling to get them integrated into a curriculum for all. They also investigate their own cognitive styles and ask the schoolsystem to take it into account. They raise ethical questions about the environment and want to see it back in science education.

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GASAT-4 (Ann Arbor, Michigan, USA, 1987)

Professionally stimulated by the fact that the GASAT-idea had spread so widely, the conference agreed that GASAT should go on growing international. It was thus decided to accept the offer of the University of Michigan, Ann Arbor, USA, to organise the fourth conference in 1987.

PUBLICATIONS

The following publications exist of GASAT-conferences:

Proceedings GASAT-conference 1981, vol. 1
report of the conference
Contributions GASAT-conference 1981, vol.2
text of the conference papers
Girls and science and technology, vol. 3
congressbook GASAT-conference 1981
Eds. Jan H. Raat, Jan Harding, Ilja Mottier
Eindhoven University of Technology
Contact: Jan H. Raat, University of Technology, Postbox 513,
5600 MB Eindhoven, The Netherlands

Contributions to the second GASAT-conference , 1983
Conference report, 1983
Ed. Svein Lie
Institute of Physics, University of Oslo.
Contact: Institute of physics, University of Oslo,
Postbox 1048, Blindern, Oslo 3, Norway

Contributions to the third GASAT-conference , 1985
+ supplement
Chelsea College, London
Contact: Jan Harding, Chelsea College, University of London,
Bridges Place, London SW6 4HR, England
(Chelsea College is going to move, but mail will still able
to arrive)

For GASAT-4, contact:
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